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THE PROFESSIONAL MAN IN THE MODERN STATE

THOSE men of science who are familiar with the study of "The Professions" which Sir Alexander Carr-Saunders and Mr. P. A. Wilson gave us in 1933 will welcome the survey of "The English Middle Classes" which Mr. R. Lewis and Mr. A. Maude have recently made*. While this new book does not diminish the need for a new edition of the earlier work, some of the changes in the professions which have occurred during the last sixteen years are reviewed and some of the new problems which have emerged are discussed, though in a wider context. Moreover, passages in the book are quite as pertinent to discussions on the recent report of the Royal Commission on Population or on the place of voluntary organisations in Britain to-day which the publication of Lord Beveridge's "Voluntary Action" and its supplementary volume have provoked. There are shrewd observations on education, on the Civil Service and on issues raised by the nationalization of industry, and no scientific worker who is concerned with the defence of freedom, whether in the universities or in its wider context in public and social life, can fail to read much of this book with deep interest and appreciation.

The security which the middle classes have hitherto enjoyed has meant freedom and independence, and these in turn, based upon a secure income and a high standard of living, have led to a critical spirit and encouraged experiment in art, in science and in politics. The growing threat to the independence of the middle classes is thus a threat to the whole structure of society. In the main, the middle classes have supplied the intricate social mechanism required by our elaborate civilization; and in their ever-more elaborate training for the acquisition of special skills, they ensure its continuance. Factors which prevent our requirements of men of science, teachers, managers or other brain workers being met endanger the whole structure. Fundamental thought as well as practical organisation underlies the whole range of the activities of modern society, and not least in politics. Just as industrial progress depends on fundamental scientific research, so the functioning of political institutions depends on the administrators being able to see what they are doing, to step back and consider the whole, to rectify mistakes and to keep the system flexible—and therefore viable.

Nor are the middle classes of Britain important solely because their independence has favoured the discharge of such functions. They are important also as a stabilizing factor, since they include both employees of labour and the employees of other men and of the State. This characteristic sometimes raises problems in professional organisation, but is a small price to pay for the existence of strong influences which work to resist unreasonable demands by capital, by labour or by the State. Already experience under nationalization has shown the need for

* The English Middle Classes. By Roy Lewis and Angus Maude. Pp. 320. (London: Phoenix House, Ltd., 1949.) 15s. net.

such influences if injustice to individuals is to be prevented or redressed, and there is nothing to suggest that society in the future will have any less need of those able, in Mr. Lewis's and Mr. Maude's words: ". . . to reward and encourage those whom the State ignores or dislikes; to find employment for those whom the State rejects; to patronise those whom the masses repudiate; to prosecute enterprises which are ahead of their time, or behind it; to back the individual against the committee; to organise for purposes not yet acceptable to the official mind; to carry a law case to the House of Lords or a shipload of dissenting citizens to the New World".

The ability to back one's own judgment without fear or favour is likely to remain all-important, and from this emphasis on initiative as the essence of middle-class activity, Mr. Lewis and Mr. Maude proceed to illustrate their generalization by examining particular sections of the middle classes. Commending Mr. H. E. Dale's book, "The Higher Civil Service of Great Britain", they point to certain factors which are depreciating the quality of the administrative class. Already its work has suffered in quality through the overstrain of the last ten years, and although complete breakdown is unlikely, the quality of administration for many years to come, possibly for a whole generation, has been jeopardized by the pressure put upon the key men of the public service during the past years; and if some of the newer men who have in recent years entered the Service, full of organising enthusiasm and ideas but who have not yet had time to grasp the principles of administration, became the dominating element in the Civil Service, Britain might find itself with a real bureaucracy on its shoulders.

Generally, the trouble arises from the infliction on Departments of State of tasks for which their resources and organisation are unsuited. There are also indirect consequences which are equally serious. Confronted with slowness and lack of efficiency in the administration of restrictive controls, the public is not only developing a sense of hostility towards the officials, but also endeavours to short-circuit, when it does not actually ignore, the controls. Besides the deplorable effects of this tendency on public morality, an unfortunate element of party politics is liable to enter the sphere of administration when the volume of detailed Government controls is reduced. The decision to lower the educational standards required for entrants to the executive and clerical classes, in Mr. Lewis and Mr. Maude's opinion, is likely to result in nothing but harm, and they enter a timely and spirited warning against dangers which might result from injudicious opening of direct entry to the administrative class.

If vigour, energy and decision are to become the dominant qualities of officials to the detriment of the judicial qualities for which they are now justly renowned, the results could be very dangerous, and it seems clear that much more thought must be given to this question of selection of Civil servants. On the Scientific Civil Service Mr. Lewis and Mr. Maude make little comment, though some observations on the relation of the man of science to the administrator deserve to be noted. They suggest that while the executive and clerical services may become less attractive for the middle classes, the effect of the controls on industry and business may be to increase the attractiveness of the administrative class. This may, however, be offset by the competition of the public boards, and the question of recruitment to the staffs of the nationalized industries is one of vital concern to the Civil Service Commissioners.

The effect and implications of the new extensions of State responsibility are further illustrated in the chapter in which the problems of the professions are considered, and in particular those which the National Health Service raises for the profession of medicine. The crucial issue is the extent to which the duty of ensuring that the public is getting value for the taxpayers' money entitles the State to interfere in the actual practice of the calling. Not only the current terms on which grants are made and the avowed aims of those in power at the time have to be considered, but also the ways in which existing powers could be used by future governments.

This, of course, is precisely the reason for Sir David Rivett's comments regarding recent changes in the constitution of the Council for Scientific and Industrial Research in Australia; most forms of official regulation can—directly or indirectly—threaten the intellectual freedom and integrity of teachers. Mr. Lewis and Mr. Maude lay their main stress on the way in which State monopoly of employment in a particular profession affects the livelihood and mental outlook of the practitioner. Sir Alexander Carr-Saunders and Mr. P. A. Wilson made exactly this point in 1933. So long as the State only employs a fraction of the members of a profession, their self-determination is not impaired or endangered. They derive their primary professional status, not from the State, but from their professional organisations. When, however, the State becomes their sole employer, not only does dismissal mean inability to practise their craft; the self-determination of the profession is also affected because under such conditions the State could not permit the professional organisation to confer a hall-mark of competency.

The problems which nationalization presents to the professions were thus clearly delineated by Carr-Saunders and Wilson, and the neglect not only of the medical but also of other professions to consider them well in advance fully substantiates their comment on Prof. A. N. Whitehead's criticism of the professions —that professional men, while not innately reactionary or unprogressive, lack vision. Nor are professional men alone open to criticism here. Mr. Lewis and Mr. Maude emphasize, indeed, that the present situation results from a social and intellectual trend for which the professional class as a whole is responsible; that it is the result of thinking and planning in a series of separate compartments, of blinkering professional vision, of excessive specialization, or even of excessive professionalism. But they equally stress that it demonstrates the danger of planning new

social services or measures of nationalization in isolation, without paying enough attention to the mental climate of the nation at the time and without setting on foot measures to compensate for the secondary effects of the reforms.

This is primarily an indictment of the doctrinaire politician; but Lewis and Maude regard the excessively specialized and expensive training which has resulted from the growth of specialization and the desire to raise the status and economic position of a profession, with the consequent narrowing of culture, as an important factor. They give a clear warning, too, that all the evidence suggests that increased dependence on the State results in a progressive lowering of the social and economic status of a profession, and when they suggest that only the survival of a strong body of medical practitioners outside the service of the State can guarantee the status and income of the medical men inside the service, it behoves scientific workers in general to consider the implications for scientific work and life of the growing proportion of men of science employed directly by the State.

It is in keeping with these observations that in their comments on middle-class education Lewis and Maude stress that a university education should be more than a mere vocational training for a job, and that the corollary of university expansion should be the realization that a university education does not automatically entitle a man or woman to a job carrying a definite status. They remind us of the social dangers of graduate unemployment and are clearly of the opinion that university education is offering less and less beyond mere vocational training, and that the universities are not fulfilling their function of turning out cultured men and women. Such questions are antecedent to that of the independence of the universities; and may be more appropriately discussed on another occasion. Here it will suffice to quote Lewis and Maude's comment that the medieval university did not turn out such half-men as the scientific worker largely ignorant of literature and with the haziest idea of the historical processes which give rise to scientific discoveries and of the social and ethical framework in which science operates to-day, or the man of letters or the lawyer ignorant of the structure of science, or the medical man who is a stranger to philosophy.

Such deficiencies go far to explain those professional failures which are so evident on reading again the last two chapters of Carr-Saunders and Wilson's book in the light of our post-war experiences. It is our failure to work out a satisfactory relationship between expert knowledge and popular control which is primarily responsible for the difficulties which have attended nationalization and the development of the social services.

For such neglect professional men are at least partly to blame. Had they, as suggested nearly two decades ago, given serious thought to the problem of the methods which professional associations should employ to present their views and which the State should use to obtain their advice, some mistakes and breakdowns would assuredly have been avoided. They must accept a major responsibility for establishing and improving the channels of communication between knowledge and power and keeping them manifold and clear. But some responsibility lies on the politician and on the ordinary citizen. As Zimmern pointed out twenty years ago, the issue is not whether the common man is or is not to have a share in government. It is whether his share is to be an unhelpful participation in a clumsy system of checks and balances, or an allocation corresponding to the special contribution he is fitted to make.

In displaying so clearly the forces which are threatening the middle classes to-day and which, if unchecked, may lead to their replacement by a class of officials, equally a middle class, but devoid of those qualities of initiative and independence which have rendered such great service in the past, "The English Middle Classes" issues a challenge to the professional classes at least as striking as that of Sir Alexander Carr-Saunders and Mr. P. A. Wilson. The favourable climate required for creative advances in any field, whether administrative, academic, scientific or cultural, and which in the main over the last century and more the middle classes in Great Britain have provided, is now in grave danger. As pointed out in a series of articles in *The Economist* last year, leisure, privacy and the opportunity for external contacts are as essential for high intellectual activity as extra rations to heavy manual labour.

The professional class has a unique contribution to make to the welfare of the community—a contribution essential to the success of the twentieth-century experiment of combining individual freedom with the deliberate attempt to control the economic environment of society; and efforts must be made to see that conditions inimicable to its functioning are not allowed to arise.

HOMAGE TO SIR JOSEPH BARCROFT

Hæmoglobin

A Symposium based on a Conference held at Cambridge in June 1948 in memory of Sir Joseph Barcroft. Edited by F. J. W. Roughton and J. C. Kendrew. Pp. xii + 317 + 12 plates. (London: Butterworth's Scientific Publications, 1949.) 40*s*. net.

IN June 1948 a symposium on hæmoglobin was convened in Cambridge to do honour to the memory of Sir Joseph Barcroft. The world-wide response to invitations was such as to give this meeting the atmosphere and standing of an international congress, and it is indeed fortunate that the proceedings have been published *in extenso*. This book contains tributes to Sir Joseph from his successor, Prof. E. D. Adrian, and seven other distinguished physiologists, together with the twenty-eight papers that were presented at the symposium. A gathering of specialists of such distinction in the hæmoglobin field is in itself an outstanding event, and to do justice to their contributions is impossible within this short space.

The papers of Prof. D. L. Drabkin and F. J. W. Roughton deal with the determination of the oxygen dissociation curve *in vivo* and with the effect of factors such as high pigment concentration and the cell-wall barrier on gaseous diffusion. An analysis of the various theories of the hæmoglobin–oxygen equilibrium is also given.

The structure of the hæmoglobin molecule is discussed from many angles. Prof. F. Haurowitz discusses the role of water in the hæmoglobin–oxygen reaction; Prof. L. Pauling brings forward magnetic data as basis for a theory to explain the specific reactions of oxygen and carbon monoxide with hæmoglobin; and Prof. J. Wyman discusses hæm–hæm interaction and the histidine theory of the iron–protein linkage. Papers by G. R. Tristram and Prof. A. Rossi-Fanelli show that the hæmoglobins of blood and muscle are structurally distinct on the basis of amino-acid composition, while the structural relationships of hæmoglobins, based on free amino-group assay, can be correlated with serological relationships (R. R. Porter and F. Sanger). The X-ray analyses by M. Perutz and J. C. Kendrew of hæmoglobin and myoglobin now reveal the orientation of polypeptide chains within the globin, while from X-ray scattering of hæmoglobin solutions D. G. Dervichian obtains confirmatory evidence of molecular size. The osmotic behaviour of hæmoglobin solutions in presence of salts is discussed by G. S. Adair and by H. Gutfreund. A new method for rapid determination of osmotic pressure gives a molecular weight of 66,400 ± 400 for horse hæmoglobin. Papers by M. Jope and J. R. P. O'Brien and by M. J. Karvonen deal with the differentiation of adult and fœtal hæmoglobins in terms of solubilities and crystal structure, while J. H. P. Jonxis finds a marked difference in resistivity of erythrocytes to *Rh* antibodies according to which pigment they contain.

Factors concerning the appearance and removal of methæmoglobin *in vivo* are discussed by W. N. M. Ramsay, H. Barcroft, Q. H. Gibson and D. C. Harrison, while the biosynthesis of the hæm group is discussed on the basis of the use of isotopically marked 'building stones' (Prof. C. Rimington) and also of the interference with synthesis following lead poisoning (Prof. A. Vanotti). Interesting papers on spectroscopic technique are contributed by C. de Duve on the analysis of hæmoglobin–myoglobin mixtures and by E. M. Jope on the absorption spectra of erythrocytes. The hæmoglobins of *Ascaris*, remarkable for their high oxygen affinities, are described by H. E. Davenport, while useful summaries of recent work on two other oxygen carriers, chlorocruorin and hæmocyanin, are provided by Prof. H. Munro Fox and H. P. Wolvekamp.

As a contribution to hæmoglobin studies this book is unique. Two lasting impressions are the advances in experimental technique which may be traced to the influence of Sir Joseph Barcroft, and the completeness with which the entire field is reviewed. It is easy to avoid the *cliché* that this book should be in the hand of every worker in the field, since it will inevitably find its way there, and, indeed, to a much wider circle. The editors are fully justified in concluding their preface with the words, "We believe that the astonishing range of subjects comprised in this volume would have given the utmost delight to the late Sir Joseph Barcroft, who was indeed the fountain-head of so much of all this varied work. If so, there can be no more fitting memorial to him."

SYMPOSIUM ON MATHEMATICAL STATISTICS

Proceedings of the Berkeley Symposium on Mathematical Statistics and Probability
Held at the Statistical Laboratory, Department of Mathematics, University of California, August 13–18, 1945, January 27–29, 1946. Edited by Jerzy Neyman. Pp. viii+501. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1949.) 42*s*. net.

A FRENCH writer has recently remarked that whereas the twelfth and thirteenth centuries saw the creation of the first universities and the sixteenth and seventeenth the first academies, it was not until the nineteenth that the international congress made its appearance as a serious instrument for the advancement of science. He might perhaps have added that the twentieth century is evolving another method of synthesizing scientific thought, the symposium, in which a number of workers come together to discuss a single scientific theme from various points of view. It is an interesting, perhaps an inevitable, development from the solo towards the orchestral attack in science which might itself form the subject of scientific discussion.

The present volume contains twenty-nine papers on mathematical statistics and probability presented at a conference held in Berkeley, California, in August 1945 and January 1946, with the object of marking the end of the War and of stimulating the return to theoretical research of those statisticians who had been occupied by practical war-time problems for the previous four or five years. The contributors are all inhabitants of the United States. Their work constitutes a symposium in the sense that they came together to deliver their papers; but the theme is so wide that the papers have little in common, ranging in length from six to sixty pages and in subject from the philosophical foundations of probability to the sampling of rainfall in mountainous areas and the biological association of insects. Both the symposium and the publication of these proceedings, which make a handsome volume of some five hundred pages, were assisted by a special grant from the University of California.

The papers fall into three main classes: on fundamentals (Reichenbach on probability and Copeland on a postulational characterization of statistics); on general theory (such as Pólya on characteristic functions and on the probability integral, Neyman on the chi-squared test and Hsu on the limiting distributions of sample means); and on applications (such as Lenzen on statistical mechanics, Dresch on index-numbers, Trumpler on the galactic star system and Wyckoff on the work of the California Forest and Range Experiment Station). Prof. J. Neyman contributes a short introduction and has acted as editor; doubtless the symposium was his in conception and organisation.

A paper by Hotelling, with discussion, on "The Place of Statistics in the University" is of general interest to all teachers of scientific subjects. Hotelling can be read with pleasure on any subject; but on none more than this, in which authoritative American and British ideas seem to be in line, but in which American performance is substantially ahead. The reviewer also found of great methodological interest Brunswik's long paper on the design of psychological

experiments, which foreshadows the approaching crisis in the philosophy of experimentation. Is the laboratory or the field the right place for an experiment, and how far should research be operational?

Several of the papers are in the nature of surveys of particular fields: Wolfowitz on non-parametric inference, Doob on time-series and harmonic analysis, and Feller on stochastic processes. Although written four years ago (a long time on the current statistical time-scale), they are very useful and must have done much to further the objects of the symposium.

M. G. KENDALL

ELECTRICAL ENGINEERS' HANDBOOK

Standard Handbook for Electrical Engineers
By Archer E. Knowlton (Editor-in-Chief) and R. M. Shoop (Assistant Editor). Eighth edition. Pp. xi+2311. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 72*s*.

THE "Standard Handbook for Electrical Engineers", first published by the McGraw-Hill Book Co. in 1907, has reached its eighth edition. This work has occupied a place on the bookshelves of electrical engineers throughout the world for so long a period that it has, indeed, established its claim to its title.

The subject-matter of the book, which comprises a little more than 2,300 pages, is divided into twenty-six sections covering the whole range of electrical technology in power and telecommunication applications. It is stated in the preface that it was considered that the previous edition had reached the limiting practicable dimensions and that, in preparing the present edition, pressure had been put on the contributors to condense their material to a point just short of incompleteness or ambiguity. Extensive sampling of the various sections suggests that a very satisfactory result has been achieved. In general, the salient points are treated at sufficient length to be readily intelligible, and references to the literature indicate sources of detailed information on specific points.

A number of subjects of comparatively recent development now constitute complete sections or sub-sections. For example, under Section 26, "Electro-physics", there is given a very satisfactory outline of nuclear energy and radioactivity, while radio, radar and carrier communication together constitute the subject-matter of Section 24. Dielectric heating and eddy-current heating are treated in the section on "Electric Heating and Welding", and under "Electricity in Transportation" there is a sub-section dealing with the electrical equipment of aircraft. Electrical servo-mechanisms form a sub-section under "Industrial and Commercial Power"; but it is perhaps a little remarkable that only six pages should be allocated to this important topic. The properties of the newer dielectric and magnetic materials are summarized satisfactorily in Section 4. There does not, however, appear to be any information on ferrites, and there is no indexed reference to non-linear resistors other than carbon.

The handbook is, of course, a guide to American practice, and numerous tables, data and references which are of the utmost value to the reader concerned with American installations are of less direct utility to the average British user. Very far-reaching, although in many instances comparatively slight, differences result from the difference between the American standard supply frequency (60 c./s.) and the British (50 c./s.). The numerous references to the specifications of the American Standards Association and the American Society for Testing Materials are again of less direct value to the British reader. References to text-books and scientific publications are, of course, predominantly American; but contributions from other countries are well represented in most sections, and the bibliographic material has been judiciously selected.

There are, not unnaturally, noticeable differences between sections in the rigour with which obsolescent material has been pruned and the efficiency with which new material has been grafted. On the whole, however, the revision has been remarkably well done, and the "Handbook" remains one of the most valuable sources of summarized information and reference on electrical matters. The new edition maintains in the fullest sense the high standard set by its predecessors.

J. GREIG

TREATISE OF ZOOLOGY

Traité de zoologie
Anatomie, systématique, biologie. Publié sous la direction de Prof. Pierre-P. Grassé. Tome 6: Onychophores, tardigrades, arthropodes, trilobitomorphes, chélicérates. Pp. viii+980. (Paris: Masson et Cie, 1949.) 5,000 francs.

Traité de zoologie
Anatomie, systématique, biologie. Publié sous la direction de Prof. Pierre-P. Grassé. Tome 9: Insectes; paléontologie, géonémie, aptérygotes, ephéméroptères, odonatoptères, blattoptéroïdes, orthoptéroïdes, dermaptéroïdes, coléoptères. Pp. viii+1118. (Paris: Masson et Cie, 1949.) 4,500 francs.

IN reviewing the first volume to be produced of this new "Treatise of Zoology", actually Volume 11 in the series (see *Nature*, February 19, p. 269), it was pointed out that in publishing a series of large volumes there is a danger that the earlier ones may become out of date before the later ones appear. The publishers seem to be doing their best to avoid this, since two further volumes are now to hand, and another, Volume 15, on birds, is announced to appear during the present year. It may be said at the outset that the present volumes fully maintain the high standard of printing and illustrating of their predecessor, and the coloured plates in both are very good. The practice of including a treatment of fossil groups in their systematic position, although from the nature of the material it cannot be so full as in the case of living groups, and of discussing their relationship, is to be commended since it gives a more satisfying picture of the animal kingdom as a whole than dealing with them in separate and unrelated publications. It is a pity that the size of the animal illustrated is not indicated more consistently, as it is in the Coleoptera, particularly in the more unusual and bizarre forms.

Volume 6 of the series, a book of 980 pages, contains 719 text figures, 46 of which are in half-tone and the remainder in line block; five of the latter are reinforced with colour, and, in addition, there are four coloured plates. Its contributors are M. André,

L. Berland, C. Dawydoff, L. Fage, W. Millot and M. Vachon, all of Paris, L. Cuénot of Nancy, L. Störmer of Oslo, A. Vaudel of Toulouse, and G. Waterlot of Lille. These authorities are sufficient guarantee of the standard of the work. The first three sections deal with the Onychophora, Tardigrada and Pentastomida as groups, the relationships of which to the Arthropoda *sensu stricto* are not clear. This is followed on pp. 79–158 by a useful discussion on the general characters of the Arthropoda, and this in turn by a treatment of the Trilobitomorpha and the Chelicerata, the latter being synonymous with the Arachnida of English text-books. There are a number of slips that have escaped correction: for example, p. 96, Easthman instead of Eastham as it is correctly spelled in other places; p. 122, the legend of the plate refers to figures *A*, *B* and *C*, but these letters do not appear on the plate itself; p. 124 gives references to a special Chapter 20, but none of the volumes so far published is divided into chapters, and the subject-matter is not treated in the present volume; Lankester's classical paper is quoted, pp. 261 and 892, as "Limulus and [instead of 'an'] Arachnid"; the works of Meglitsch and Thomsen on the corpus cardiacum are mentioned in the text, but do not appear in the list of references, etc.

Turning now to Volume 9, as is to be expected with such a vast amount of material to be dealt with, the Insecta occupy three volumes of which this is the middle one. The volume contains 1,118 pages and is divided into two sections; the first is illustrated by 109 line blocks and a double-page coloured diagram to show the classification and phylogeny of the Insecta, and the second is illustrated by 728 line blocks, 24 half-tones and two excellent coloured plates. The outer cover is provided with an effective, lightly embossed representation of the beetle *Enneopaussus hova* in gold and black. Its contributors are L. Chopard and R. Jeannel of Paris, R. Denis of Dijon, R. Despax of Toulouse, E. Paulian of Madagascar, and the general editor, Pierre-P. Grassé of the Sorbonne, deals with the termites. The first section is concerned with the classification of insects, including a brief historical survey, and indicates that the classification adopted is that proposed by Martynov with slight modifications. It also discusses the fossil insects and their position in classification, and the phylogeny, evolution and spread of the major groups of insects in general. The second section deals, in order, with the various lower groups and also the Coleoptera. Again, as in the previous volumes issued, slips have remained uncorrected; for example, p. 9, the name is given as Martinov, whereas on pp. 6, 13–19 it is correctly given as Martynov; on p. 591 miss Ford instead of Miss Ford, etc. In view of the considerable interest now taken in chromosomes, it is a pity that, as they are mentioned, those of Orthoptera and Coleoptera do not receive fuller treatment and illustration. Particularly is this the case in the former group, where the relatively large size of the germ cells has resulted in a great deal of attention being paid to them.

The criticisms of both volumes are only minor ones; but the general standard is so high that it is a pity such blemishes have been left. Both volumes are provided with full indexes and a table of contents right at the end. The value of such large works as these can only be determined by continuous use, but they are to be strongly commended and should find a place in every zoological library.

C. H. O'Donoghue

FISHES OF THE WESTERN NORTH ATLANTIC

Fishes of the Western North Atlantic

Part 1: Lancelets, by Henry B. Bigelow and Isabel Pérez Farfante; Cyclostomes, by Henry B. Bigelow and William C. Schroeder; Sharks, by Henry B. Bigelow and William C. Schroeder. (Sears Foundation for Marine Research, Memoir No. 1.) Pp. xvii+576. (New Haven, Conn.: Yale University, 1948.) 10 dollars.

From the time of its appearance half a century ago, Jordan and Everyman's "Fishes of North and Middle America" has until to-day remained the only comprehensive descriptive account of the fishes of the western Atlantic Ocean. Much new knowledge has become available during this long period, and the time is now ripe for a new and up-to-date publication covering approximately the same field. The appearance of Volume 1 of "Fishes of the Western North Atlantic" is therefore most welcome and will supply a much-felt need. This volume, the first of a projected series, brings to fruition the initial part of a plan conceived in New Haven a considerable time ago. With the establishment of the Sears Foundation for Marine Research at Yale University in 1937, funds became available for publication on quite an ambitious scale, and a group of expert ichthyologists met to discuss the preparation of a work such as is now appearing.

The various sections will be written by specialists in their particular fields and will be critical reviews, or even revisions, of each group based on the latest and most up-to-date information and ideas. The schemes of classification will be compiled with especial care, and standards for both text and illustrations have been formulated so as to achieve as much uniformity as possible throughout the different volumes. The scope of the publication will embrace the sea- and brackish-water fishes of the western half of the North Atlantic, including the adjoining gulfs and seas from Hudson Bay to the Amazon River. Although written by specialists, "Fishes of the Western North Atlantic" is designed to be of interest and value not only to professional but also to amateur biologists, such as fishermen and sportsmen and all others interested in the lives and habits of fish.

Volume 1, now published, describes the lancelets, hag-fishes, lampreys and sharks. For each group, adequate and well-conceived keys are provided to families, genera and species. An attempt is made to describe clearly and succinctly the distinctive characters which separate each species from its nearest relatives. In general, this is successful and is a very useful feature of the book. The specific descriptions are comprehensive (including, for the sharks, long lists of proportional dimensions of selected specimens, the value of which may perhaps be doubted) and are followed by extensive discussions of colour, size, habits, abundance, range, occurrence and distribution in the western North Atlantic, and economic importance. There are full lists of synonyms with references.

The book is well produced, well illustrated in black-and-white and handsomely bound. The size is royal quarto. This, and each succeeding volume of the series, as it becomes available, should most assuredly find a place in the libraries of all institutions and individuals interested in the fishes of the region.

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MULTIPLICATION OF THE ANIMAL VIRUSES

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BACTERIA possess their own enzymes and can synthesize to a greater or less degree all the substances which are necessary for their growth; in consequence, pathogenic forms have a metabolism which is distinct from that of their host, while nearly all bacteria can be grown *in vitro* in the absence of living cells. Viruses are often considered to represent a degenerative simplification of this condition in which the enzymic equipment, although tacitly assumed to be present, is defective to such an extent that a dependence upon host metabolism has developed which deprives the virus of the capacity for independent growth. While this may perhaps be the case in the Rickettsiæ, which fall outside the scope of this article, a consideration of the available literature leaves one with the impression that there is little, if any, definite evidence that the true viruses have any enzyme activity at all, while their multiplication may well be more closely related to the mechanisms of heredity than to the growth of bacteria, being secured by some form of control over the metabolism of the host which recalls the control of the activities of the cytoplasm by genes and organisers.

Enzyme Activity of Viruses

Investigation of the biochemical activities of animal viruses is rendered difficult by the fact that pure preparations cannot be easily obtained; only a limited number of viruses are sufficiently amenable to purification procedures. These are in any event necessarily protracted, thereby affording opportunity for bacterial contamination, while viruses must usually be extracted from tissues which are rich in enzymes, which may not be completely separated from the virus bodies in the course of purification. These facts may be borne in mind when considering Table 1, in which published information concerning enzymic and related activities of viruses has been collected, together with some personal observations on the enzymic activity of influenza virus. There is good evidence that representative enzymes of glycolysis, respiration, nucleic acid synthesis and tissue invasion do not occur in the viruses studied. The negative results with influenza virus were obtained in some cases with virus concentrated a hundred-fold by red cell adsorption from fresh allantoic fluid (desoxyribonuclease, adenosine triphosphatase); fresh virus-containing allantoic fluid sometimes showed a slight phosphatase and dehydrogenase activity which was not reduced by red cell adsorption and which could not, therefore, be associated with the virus particles. The reported occurrence of certain enzymes in suspensions of vaccinia is far from satisfying. Preparation of the suspensions involves a considerable amount of manipulation, during which bacterial enzymes may gain access to the material. In the case of phosphodiesterase, the virus-substrate mixtures were incubated for up to seventy-two hours. In ordinary tissues, or with bacterial suspensions, phosphatase activity may be detected after thirty minutes incubation or less, and, even after allowance for the fact that only a small quantity of virus substance was present, it is more likely that the trace of phosphatase activity observed was due to contamination with tissue or bacterial enzymes, or even to decomposition of the substrate during prolonged incubation. Ribonuclease and desoxyribonuclease activity were detected, but only during an incubation extending for ninety-nine hours; these enzymes are usually sufficiently active to enable their presence to be detected with a 30-minute period of incubation; the substrates are, moreover, unstable and might well decompose to a certain extent under the conditions of the experiment. The reported occurrence of biotin and riboflavine in vaccinia is of interest in view of their co-enzyme nature. Riboflavine was present in a very small amount (1 mgm. per 100 gm.), and may therefore have been a contaminant; but biotin was present in comparatively large amounts and may be a genuine constituent of the elementary bodies. It has been shown[9] that vaccinia elementary bodies adsorb phosphatase, catalase and lipase, so that the enzymes can be removed from solution by the addition of elementary bodies followed by centrifugation to sediment the virus. This observation makes it all the more improbable that enzymes apparently associated with elementary bodies are genuine constituents.

The conclusion that influenza virus contains mucinase is based on the fact that the virus agglutinates the red cells of a number of animal species, that the cells can be rendered insusceptible to the action of the virus by previous treatment with mucinase of bacterial origin and that a given amount of virus is apparently capable of reacting with an unlimited

Table 1

Virus	Reference	Absent	Present
Vaccinia	1	Zymchexase Enolase Phosphoglucomutase Adenosine nucleosidase Peptidase Triosephosphate dehydrogenase	Phosphodiesterase Ribonuclease Desoxyribonuclease Phosphomonoesterase
	2	Cytochrome oxidase Cytochrome C	Riboflavine Copper
	3		Biotin
	4	Hyaluronidase	
Influenza	5, 6		Mucinase
	7	Mucinase	
		Desoxyribonuclease Phosphatase Xanthine oxidase Adenosine triphosphatase Succinic dehydrogenase	
Lansing	8	Hyaluronidase	
MM	8	Hyaluronidase	

number of cells, in the manner of an enzyme activating an unlimited amount of substrate. It has been claimed that influenza virus will bring about a reduction in the viscosity of a solution of mucin[6]; but the evidence is unconvincing to those with experience of viscosimetry in biological work. It has recently been denied that influenza virus has any action on mucin[7]; but the lack of agreement between these results may be due to differences in the composition of the substrates employed. The mucinase activity of influenza virus needs to be put upon a firmer footing by characterization of the enzyme and its substrate; if it be accepted that this is a true enzyme action, it stands in remarkable contrast to the lack of other enzyme activities shown by influenza and vaccinia viruses. It may act only as a means of attaching virus to the surface of those cells which form a suitable site for its proliferation, without playing any part in virus metabolism.

Relation of Viruses to the Enzyme-containing Structures of the Host Cell

From a consideration of the foregoing it seems improbable that viruses are generally endowed with enzymic activity, at least so far as one can generalize from the limited information available. If this be the case, the metabolic activities necessary for the synthesis of new virus material must be contributed by the host cell; this implies that the virus must exert some sort of control over the enzymes of the host. These are not distributed at random throughout the cytoplasm, but are located for the most part in discrete bodies known as chromidia[10]. These are round, with an average diameter of 50–300 mμ, and are thus of the same order of size as the virus body. They contain ribonucleic acid, calcium and magnesium, phosphatides and lipides, and respiratory and hydrolysing enzymes. They are linked together in chains by fused strands of polypeptides which form filaments known as interchromidia which are about 50 mμ in thickness. The ribonucleic acid is probably concerned with protein synthesis and is activated and inhibited by the magnesium and calcium ions; the lipides are considered to form a screen between the enzymes and their potential substrates so as to prevent the dissolution of the whole structure. After entering the host cell the virus must act upon the chromidia, and new virus material must be laid down in their neighbourhood. There is a certain amount of evidence available which could be interpreted as showing that virus bodies have an affinity for the chromidia and develop in contact with them. The course of development of psittacosis virus in the chorioallantoic membrane has been studied by electron microscopy[11]. The membranes were prepared for examination by disruption by sonic vibration. Many round bodies attached to fibres were seen, both in infected and in uninfected control membranes; although no interpretation of these structures was given, they were recognized to be normal cell constituents; they must, in fact, be the chromidia and interchromidia. Virus-like bodies were seen attached to the presumed chromidia, although the appearance was interpreted as division of a virus body. Many examples were also seen of virus-like bodies attached to fibres which were presumably interchromidia. These observations suggest very strongly that the virus develops in close association with the enzyme-containing structures of the cytoplasm.

A direct relation between virus infection and enzyme activity has also been demonstrated[12,13]. In mouse brain infected with the viruses of neurotropic yellow fever, lymphocytic choriomeningitis and lymphogranuloma inguinale, a considerable increase of xanthine oxidase activity occurs; a similar occurrence is seen in chick embryos infected with the 17*D* strain of yellow fever virus[14]. In the latter case there is some evidence that the increased enzyme activity represents a synthesis of new enzyme in response to the virus infection. Whether this be the case or not, it seems likely that the virus, after gaining entry to a cell, exerts some sort of control over the cell metabolism, presumably by directly affecting the chromidia. An affinity between virus and enzyme has been demonstrated by the work on vaccinia already described[9], in which it was shown that vaccinia elementary bodies would adsorb phosphatase, catalase and lipase from solution. A certain specificity was also observed, since a plant enzyme, urease, was not adsorbed by the virus. One might speculate that the virus has an affinity only for those enzymes which are required for the synthesis of new virus material.

Development of the Virus Colony

In the work on psittacosis virus already quoted[11], it was noted that virus could not be found in the chorioallantoic membrane six hours after infection had occurred, and that while some virus bodies were seen after twelve hours they did not become numerous until twenty-four hours or so after infection. The development of psittacosis virus has also been studied by dark-ground photography of cells in tissue culture over prolonged periods[15]. For eight hours or so after infection has occurred nothing can be seen in the cell; then, some time between eight and twenty-four hours, a homogeneous plaque appears, 5–10 μ in diameter. This event seems to occur quite suddenly, within an hour or so. The plaques enlarge and can be seen to be composed of comparatively large round bodies; as the colony enlarges, the round bodies decrease in size and become elementary bodies, which are liberated by rupture of the cell. In certain cases it was possible to trace the origin of a colony backwards beyond its time of appearance as a visible plaque, as it could be distinguished as an area of cytoplasm which, although of normal appearance, showed no Brownian movement. This suggests that the colony is formed out of normal cytoplasm which is smoothly transformed into virus material; moreover, large colonies may increase in size so as to fill the whole cell, suggesting a successive systematic conversion of cytoplasmic components into virus material.

These observations can scarcely be reconciled with the prevalent concepts that viruses multiply, like bacteria, by a process of binary or plural fission. A somewhat less detailed study has been made of the development of the colonies of lymphogranuloma[16] in mouse brain. Here the earliest appearance was that of a mass of large bodies, containing from twenty up to several hundreds, which eventually condense into the smaller elementary bodies. Here again there is a suggestion, not of the production of a colony as the end result of a continuing process of fission, but rather of the sudden appearance of a preformed mass of large bodies, as in psittacosis. Elementary bodies were often seen occurring in pairs or in short chains. This appearance

was interpreted as indicating multiplication of the elementary bodies by fission; but such an arrangement would be expected if virus bodies are laid down in association with chromidia, which are themselves arranged in chains. The large body of psittacosis and lymphogranuloma may represent a diffuse deposition of new virus material adjacent to a chromidium, which condenses in the process of organisation into a smaller elementary body. This would account for the observed occurrence of large bodies in young colonies and their virtual disappearance from mature colonies. The development of lymphogranuloma virus has also been studied in infections of the yolk-sac[17]. Observation of stained sections showed that virus material first appeared, again rather suddenly, twelve hours after infection, in the form of initial bodies of diameter 1 μ. These increased in size to form plaques of diameter up to 7 μ, in which elementary bodies then appeared. During this cycle the yolk-sac is not infective; the titre of virus in the yolk-sac rises when the elementary bodies appear, but then falls again. This fall was interpreted as due to a loss of virus into the yolk, but it could be that the virus is not infective in the early stages of cellular re-invasion. Essentially similar appearances have been described for other viruses of the psittacosis–lymphogranuloma group[18].

Of viruses not belonging to this group, vaccinia and ectromelia have been studied by dark-ground observation of infected chorioallantoic membranes *in vivo*[19]. In ectromelia infections nothing abnormal can be seen for twenty-four hours; inclusion bodies of diameter 1 μ–2 μ then appear, and increase in size up to 8 μ. The smaller bodies are granular; the granules are embedded in a matrix and arranged in chains. This arrangement again suggests association with chromidia; the presence of a matrix also indicates that the future virus bodies arise in centres having an appreciable spatial separation, which would not be the case if reproduction were by fission. As the virus inclusions enlarge, the remaining cytoplasm does not appear to be displaced; there is rather the same suggestion of a gradually extending conversion of cytoplasm into virus which has been noted in the case of psittacosis. In the case of vaccinia, new virus material is not seen until the second day after infection. A layer of particulate material then appears beneath the cell surface, often extending to surround the whole cell. There is no sharp line of demarcation from the surrounding cytoplasm, again suggesting that virus material arises by an extending process of cytoplasmic transformation; the cytoplasm may eventually become completely replaced by virus material apparently without undergoing any process of compression or degeneration.

Soluble Phase of Viruses

These observations suggest that the entry of a virus particle into a cell is followed by the sudden transformation into virus material of a considerable volume of cytoplasm, represented by an initial body of 1 μ diameter or so, and amounting in the case of psittacosis to a plaque of 5 μ–10 μ in diameter, about 10^4 times the volume of the original virus particle. In vaccinia the first appearance is the sudden transformation of a considerable area of cortical cytoplasm. In consideration of the various mechanisms by which these changes might be brought about, the most probable seems the dissolution of the virus body into a soluble phase, which then diffuses through a considerable volume of cytoplasm and organises it into virus material by an action upon the chromidia and their enzymes. Such a soluble phase has already been postulated for influenza virus[20]. It has been shown in the case of infection of the chorioallantoic membrane by influenza virus that for six hours after infection the membrane apparently contains no virus; that is, the virus is present in some form which is non-infective. This is presumed to be the soluble complement-fixing antigen. In the disappearance of the infective phase after infection has occurred, influenza virus resembles psittacosis and lymphogranuloma.

The early stages of development of those viruses which are large enough to be examined by direct microscopy seem to be invisible as well as non-infective, so that there is a latent period between the initiation of infection and the first appearance of visible virus material. The available information concerning this latent period is summarized in Table 2; it ranges from 6 to 24 hours and seems to be of general occurrence. Its existence can be explained by the assumption that the infecting particle dissociates into an invisible phase which diffuses through the cytoplasm. By the end of the latent period sufficient new material will have been formed under the influence of the soluble phase to form a visible initial body or plaque; the size of this body would represent the extent of diffusion which had already occurred, while its subsequent enlargement might be brought about by an extension of the process of diffusion and organisation. The new virus material appears as a matrix in which centres of condensation appear, perhaps in association with chromidia, which represent the future elementary bodies. A connexion with chromidia is suggested by the spatial separation of the elementary bodies from the moment of their origin, and by their tendency to occur in chains and pairs.

Table 2

Virus	Tissue	Latent period in hours	Reference
Ectromelia	Allantoic membrane	24	19
Vaccinia	" "	24	19
Lymphogranuloma	Yolk sac	12	17
"	Mouse brain	present	16
Psittacosis	Tissue culture	8–24	15
"	Allantoic membrane	6–12	11
Mouse pneumonitis	Mouse lung	6	18
Feline pneumonitis	" "	12–18	18
Meningo-pneumonitis	" "	18	18

Soluble phases ('soluble antigens') have been found associated with certain other viruses, such as mumps[21] and vaccinia[22]. While there is no evidence which might suggest that these represent an intracellular developmental phase, the fact of their existence is at least suggestive. The soluble antigens are, moreover, of smaller size than the viruses concerned, which is a necessary condition for the hypothetical soluble phase. A considerable amount of information is available concerning the properties of the soluble (*LS*) antigen of vaccinia[23]. It is a protein of molecular weight 214,000; the molecule is elongated, with an axis ratio of 1/20. From these figures the size of the molecule may be estimated as 2×60 mμ[24]. The size of the vaccinia elementary body is 222×284 mμ[25], and it contains 89 per cent of protein; the protein

component would thus be sufficient in amount to form four thousand particles of soluble antigen. Even assuming that only a small part of the protein is transformable into *LS* antigen a large number of soluble particles could still be generated. Each of these might perhaps associate with one chromidium and organise the development of one virus body. Thus, although there is no evidence that the *LS* antigen constitutes such a phase in the reproduction of the virus, there is nothing in the available information which is inconsistent with such a view. It has, moreover, been established that the *LS* antigen is liberated from the elementary bodies *in vitro*[24] and is therefore not a by-product of infection of cellular origin. It might be argued that the absence of nucleic acid from the soluble antigen makes it unlikely that it is concerned in a process, such as virus multiplication, which involves the synthesis of protein. The soluble phase could, however, stimulate the synthesis of protein by acting upon the nucleic acid which is present in the chromidia, and would not necessarily contain nucleic acid itself. A more serious objection is the existence of other constituents in the vaccinia elementary body, such as nucleic acid and lipoids, which presumably have some function which is distinct from that of the soluble antigen and which is presumably essential for the perpetuation of virus material. There is, however, the possibility that these other constituents act as a framework on which soluble antigen is deposited, or even represent inclusions of material derived from the dissolution of cytoplasm, so that they would not participate directly in the reproductive process. There is evidence which favours the latter supposition[24]; it has been shown by means of precipitin tests that purified influenza virus derived from allantoic fluid contains an antigen which is present in uninfected allantoic fluid. This antigen constitutes up to 30 per cent of the virus particle, and is therefore a real constituent and not an impurity. Similarly, virus purified from infected mouse lungs contains an antigen which is present in normal mouse lung. It has also been shown[24] that equine encephalomyelitis virus purified from infected chick embryos contains up to 70 per cent of an antigen which is present in normal embryo tissues. These observations suggest that virus is formed by the conversion of normal cell constituents, during the course of which an appreciable amount of normal material is incorporated into the virus body in an unchanged condition. The virus body might, therefore, consist of a soluble phase carrying the power of infectivity deposited upon a framework derived from the residue of normal cell components. The influenza mucinase might represent such a residuum.

The ultimate simplification of the concept of the soluble phase is the soluble crystallizable protein of the plant viruses, where the absence of a particulate phase may perhaps be correlated with adaptation to specific methods of infection. The case of tumours which are not transmissible by filtrates may perhaps represent a condition in which a presumptive infection is prevented from leaving the cell by the absence of a particulate phase and cannot, therefore, be demonstrated by transmission experiments. If the existence of the soluble phase can be established in fact and shown to be a general phenomenon, it would unify the heterogeneity of the animal viruses among themselves and form a link with the plant viruses, which have hitherto been considered to be entirely dissimilar.

Cycles and Titres

In addition to the developmental cycles which have been directly observed in the cases of psittacosis, vaccinia and other viruses, a growth-cycle has been demonstrated for influenza virus[26,27]. When allantoic fluid is removed and titred at intervals after infection, the amount of virus in the fluid rises after six hours in the case of the *PR*8 strain, or after 9–10 hours with the Lee strain. This is brought about by the sudden simultaneous liberation of virus into the allantoic fluid. If reinfection of the membrane is prevented by injecting a large amount of irradiated heterologous virus, the titre of virus in the fluid remains constant after the rise, and a one-step growth curve can be obtained. A succession of such steps at six-hour intervals has been observed[26], suggesting a series of intracellular growth cycles. The amount of virus which is formed in one cycle can be estimated by means of a comparison of the titres of virus in the allantoic fluid before and after the occurrence of a step; a yield of sixty-three ID_{50} is found by this means for the *PR*8 strain, and thirty-six ID_{50} for the Lee strain[26]. If one assumes in the absence of precise information that the cells of the chorioallantoic membrane are cubes of side 10 μ, sixty-three virus particles will have a total volume which is only $1{\cdot}5 \times 10^{-3}$ of the cell volume. If the virus is scattered throughout the cytoplasm, or aggregated into a small colony, it is difficult to see how the presence of such a small volume of foreign material could lead to the death of the cell. It seems more likely that the virus multiplies in the nucleus, or within the cell surface, where localized damage could lead to disruption of the cell and liberation of the virus. If the virus grows within one surface of a cell of side 10 μ, sixty-three infective particles will represent approximately 1/200 of the cell surface, and their presence there might conceivably lead to sufficient damage to the cell membrane. In this connexion it is possible that the mucin affinity of influenza virus is a means of bringing the virus to a suitable tissue and anchoring it within the cell surface.

Table 3

Titre	Tissue	Virus
10^6–10^7	Mouse liver	Ectromelia, rift valley fever, lymphocytic choriomeningitis
	Mouse brain	Yellow fever, Theiler's mouse encephalomyelitis[28], louping ill[27], lymphocytic choriomeningitis, rabies[29]
10^9	Mouse brain	Equine encephalomyelitis[26], SK[21], St. Louis encephalitis[30], Japanese *B* encephalitis[30], encephalomyocarditis[31]
10^{11}	Mouse brain	*MM*[32]

A certain amount of information concerning growth cycles can be deduced for those viruses which are less amenable to experimental handling by a consideration of the maximum infectivity titres which they attain. A selection of representative titres is given in Table 3; where no reference is given, the figures are based on personal observation. The titres fall roughly into three groups: 10^6–10^7, 10^9 and 10^{11}. The minimum number of infective particles formed in one cell can be estimated from the titre and the average cell size. A calculation of this type is not

possible in the case of brain infections, where only certain specialized cells are infected, the total volume of which is unknown. In the case of mouse liver, assuming as a reasonable approximation that it consists entirely of epithelial cells of side 25 μ, a titre of 10^6, as with ectromelia or rift valley fever, gives a figure of 10^3 infective particles per gram of tissue, or a yield of between one and two particles per cell if the distribution of virus is assumed to be uniform. This latter cannot be the case, as it is unlikely that the presence of so few particles could cause any damage to the cell. If one then assumes a more reasonable figure for the yield, say a hundred, it follows that only 1 per cent of the cells would contain virus. It is extremely improbable that destruction of 1 per cent of the cells of the liver would lead to symptoms sufficiently severe to cause death. It is more likely that most of the cells of the organ are damaged, in which case they must necessarily contain virus in some form which cannot be detected by infectivity titration. Thus the occurrence of a non-infective phase, such as has already been demonstrated for influenza virus[20], can be inferred to hold also for those viruses which multiply in mouse liver. The presence of virus in maximum titre is not in itself sufficient to produce symptoms, since maximum titres can be observed some hours before the onset of symptoms in the case of infections of mouse brain with the viruses of yellow fever and lymphocytic choriomeningitis. Symptoms presumably do not appear until a large number of new cells have become occupied by the non-infective phase of the last cycle, the completion of which is interrupted by the death of the host. The exceptionally high titre attained by *MM* virus suggests that it forms a special case. A titre of 10^{11} indicates that the whole brain contains 10^{13} infective particles. Assuming as an approximation that the brain consists entirely of cells of average size 10 μ, one cell would then contain $2{\cdot}5 \times 10^3$ infective particles. While this figure is necessarily grossly inaccurate, one can at least infer that the virus must be widespread and not confined only to specialized cells, and that the final cycle is infectious and is therefore detected by the infectivity titration.

Conclusion

Future work on viruses must be directed towards a search for further examples of the existence of a non-infectious phase, and to establishing whether such a non-infectious phase can be isolated from infected tissues in soluble form. Evidence must also be sought for the existence of interactions between a virus, or its postulated soluble form, and enzymes, or enzyme-substrate reactions. It might be possible to demonstrate some sort of control by viruses over enzymes *in vitro*. It has already been found that tobacco-mosaic virus will inactivate crystalline ribonuclease by forming a complex with it[27]. This is a further example of enzyme-virus affinity, of the kind which has already been mentioned for vaccinia, and further work might reveal that enzyme affinity is a general property of viruses which is of fundamental importance in their reproduction.

Although most of what has been said in the preceding sections is entirely speculative, no kind of support has emerged for the concept that viruses are degenerated bacteria; there is much more reason for believing in the alternative view that viruses resemble genes. One is also reminded of the role of chemical organisers in embryonic induction by the way in which the virus appears to organise the cytoplasm and induce the production of new virus material. The problem of antiviral chemotherapy should be reviewed in the light of these concepts. Work up to the present has been based upon the implied assumption that viruses, like bacteria, possess a metabolism which is distinct from that of the host, and can therefore be selectively interfered with by chemotherapy. It seems more probable that the metabolism of the virus is actually that of the host itself, so that no selective interference can be possible; the problem is therefore transformed into the entirely different one of trying to interfere with the action of something analogous to a chemical organiser. The fact that viruses of the psittacosis group respond to penicillin and sulphonamides suggests that the problem in relation to viruses as a whole is not insoluble. The property of response to chemotherapy, together with certain other peculiarities, has given rise to the belief that the psittacosis viruses are distinct from other viruses, being more closely related to bacteria. Study of their development, however, leads to the conclusion that they are essentially viral in nature, have no affinities with bacteria, and are by no means sharply differentiated from the other animal viruses; one has therefore some cause for hoping that chemotherapeutic methods may be successful in virus infections in general.

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ULTRASONICS IN FLUIDS

DURING the recent meeting of the British Association at Newcastle upon Tyne, Section A (Mathematics and Physics) held a symposium on ultrasonics in fluids. Most of the papers read at this symposium concerned applications of the ultrasonic interferometer, which may be regarded as a modern development of the familiar Kundt's tube into a precision instrument for studying those properties of gases and liquids which come into play when the molecules are set into vibration as a whole. In essence, the instrument consists of a quartz crystal in piezo-electric vibration, sending out plane waves into the fluid which are reflected back to the crystal, there to react upon the circuit which maintains the piezo-electric oscillations. The reflector usually consists of a plate mounted on a micrometer screw which is carried parallel to itself in a direction perpendicular to the ultrasonic wave-front, thereby recalling several types of optical interferometer. In the original method of Pierce, the magnitude of the resonance, as indicated by the maintaining circuit, at each half wave-length shift of the screw is observed through the change in the anode current of the circuit. With some precautions, the magnitudes of these current changes may be used to calculate the absorption coefficient of the radiation in the fluid, and, of course, the screw settings for these resonances enable the velocity in the fluid to be calculated if the frequency of the crystal oscillations can be accurately measured.

Prof. A. van Itterbeek submitted a paper in which the work recently done in the low-temperature laboratory in the University of Louvain was described. There they have been making measurements in liquids and condensed gases, particularly hydrogen and the constituents of air together with some organic liquids, which they have studied down to the temperatures attainable with liquid hydrogen, that is, down to 16° K. In all these liquids, the velocity of sound was found to be a linear function of the temperature. The adiabatic compressibility and the ratio of specific heats were also calculated for each substance. During measurements on liquid hydrogen some unexpected difficulties were encountered, for the velocity of sound continually increased to an asymptotic limit (during the course of half an hour) which was about eight* per cent higher than the initial value. This result is ascribed to a continual change in the constitution of a mixture of ortho- and para-hydrogen into the pure para variety under the ultrasonic radiation, for if the latter was turned off for a while, on resumption the same value for the velocity as at the intermission was obtained (see *Nature*, March 12, p. 399).

Prof. van Itterbeek and his colleagues do not use the interferometer for absorption measurements. For this they are developing a method involving the radiation pressure on a vane suspended in the liquid at various heights above the source, so that the attenuation is determined in terms of the force on the vane and its variation with distance along the ultrasonic beam.

The remaining work on interferometry described at the meeting concerned measurements in gases carried out at King's College, Newcastle. Dr. J. F. W. Bell dealt with the effect of pressure on the coefficient of absorption, as determined in the gas contained in an interferometer. In most gases, theory would predict an attenuation coefficient proportional inversely to pressure. In fact, straight lines are obtained if the coefficient as measured is plotted against the reciprocal of the pressure, but they do not pass through the origin. Dr. Bell quoted some results of Prof. van Itterbeek in various gases contained in the *same* interferometer which demonstrated this. All these values of the absorption coefficient are in excess of those given by the Stokes–Kirchhoff theory by a constant amount—for each gas—which is ascribed to a breakdown in the simple theory of the interferometer which, as has been mentioned, supposes a plane wave system. At high frequencies, radial resonances may be set up in the tube containing the gas by inequalities in the wave-front just before the crystal—as with electromagnetic waves entering wave-guides—and these cross-modes, which are, of course, functions of the tube width, distort the wave-front and produce additional absorption not envisaged in the treatment of the interferometer as a plane wave system, which must likewise involve a 'correction' to be subtracted from the measured value if the absorption due to the gas alone is to be derived. This correction, on Krashnooshkin's theory, is equal to the value extrapolated to infinite pressure of the absorption when plotted against the reciprocal of the pressure; it is found to be proportional to the ultrasonic velocity in each gas.

Mr. H. D. Parbrook has been carrying out experiments in gases such as carbon dioxide and ethylene in the neighbourhood of their critical points. For this work, an interferometer has been built into a bomb capable of withstanding pressures of 150 atmospheres, in such a fashion that the screw may be moved by a motor while its position relative to the source and the reaction on the latter are automatically and continuously recorded on a moving sensitive film. A series of results for several frequencies and temperatures over a range of pressures surrounding the critical state has been obtained in carbon dioxide. This gas is of special interest because it shows at N.T.P. a dispersion of velocity with frequency in the neighbourhood of 100 kc./sec. It has been possible to 'chase' this region of dispersion to still higher frequencies as the pressure is raised and, near the critical point, to link up the absorption in this region with viscosities as determined thirty years ago by Phillips. Some results for ethylene are also being obtained, although, so far as is known, this gas does not exhibit a dispersion with frequency.

It is important to be able to tell in all this work precisely how much of the absorption to be shown by a dispersive gas is to be ascribed to viscosity. Some ideas on this point can be explored if the gas is submitted to an excessive—and, therefore, easily measured—absorption by placing the interferometer in a narrow tube. This can be done by setting up a miniature interferometer in a capillary glass tube, using a nickel needle in magneto-striction oscillation as source and a tight-fitting non-magnetic piston as reflector. Demonstrations of this effect were given by Mr. T. E. Lawley. Results so far obtained confirm the Kirchhoff theory of viscous absorption of sound in tubes containing air, even at frequencies of the order of 100 kc./sec.

An alternative to the Pierce type of interferometer used in all the above experiments is the 'fixed path' interferometer in which the column of gas between source and reflector is invariable, being held at a resonant length, while the stationary wave system so maintained is explored by a detector traversed along the beam. An electrically heated thin platinum wire used as an anemometer is suitable for this purpose,

since it is cooled to an extent dependent on the local particle velocity amplitude. In this way, velocities and absorption coefficients in a number of organic vapours are being measured. A modification of this technique, in which the wire is traversed in planes parallel to the face of the crystal but at different distances in front of it, serves to show to what extent at the lower ultrasonic frequencies diffraction from a forthright beam of plane waves occurs, and permits of correction to the attenuation as observed to be made in order to derive that proper to the vapour alone. This was demonstrated by Mr. K. Matta.

The remaining paper, by Dr. E. A. Alexander, of H.M. Underwater Detection Establishment, dealt with a different aspect of the propagation of ultrasonics in liquids, that is, the formation of cavities. When a sound wave passes through water, the water is alternately subjected to positive and negative pressures in the respective half-periods of the wave. As the intensity is increased and the point is reached where the negative pressure equals the external pressure acting on the water plus its cohesive force, the water breaks into a cavity, consisting of water vapour together with air which comes out of solution. As the pressure starts to increase again the cavity collapses rapidly with the production of the characteristic noise which accompanies all cavitation.

Owing to the difference in acoustic impedance between air (or a vacuum) and water or solid materials, this onset of cavitation limits the efficiency of a high-power ultrasonic transducer as an underwater signal source. The object of these experiments is to investigate this limitation in terms of hydrostatic pressure, air content and signal duration. The transducer is mounted in a tank of water with a hydrophone at a certain distance to pick up the signal. In the absence of cavitation, the signal sent out, that is, the potential applied to the transducer, is of the same form, as seen on a cathode-ray oscillograph, as that picked up by the hydrophone. When the power applied is increased to the point at which cavitation sets in, bubbles are seen in the water, the signal is distorted and an audible noise, apparently due to the collapse of the bubbles, is produced. The cavities often form at a nucleus near the transducer surface, with a 'meteor tail' spreading away from the 'head'. These may persist for the duration of the signal.

Some interesting demonstrations of ultrasonic cavitation induced in flasks of water and a high-speed ciné-film of bubble formation were shown by Mr. R. Hall.

E. G. RICHARDSON

THE COAL INDUSTRY IN GREAT BRITAIN

A JOINT session of Sections B (Chemistry), C (Geology) and F (Economics and Statistics) of the British Association was held at Newcastle upon Tyne on September 5 to discuss the present position of the coal industry in Great Britain. Prof. A. Beacham of Cardiff opened the discussion on behalf of the Section of Economics, and Mr. I. G. C. Dryden (British Coal Utilisation Research Association) and Prof. H. G. A. Hickling of Newcastle followed on behalf of the Sections of Chemistry and Geology, respectively. The proceedings closed with a contribution from Mr. W. Maclean (deputy labour director, Northern Division, National Coal Board), who took the place of Mr. Sam Watson of the National Union of Mineworkers.

Prof. Beacham argued that the task of the Coal Board has been made difficult, if not impossible, by reason of the vagueness and inconsistency of the Act by which it was constituted and by its subjection to political control. The effect of this is to be seen most clearly in the approach of the Board to its long-term technical reorganisation programme. The Board seems to be unable to make up its mind whether the 'national plan' should be dominated by efficiency factors or social factors. The Coal Mines Nationalization Act laid considerable stress on both, and in any event the last word on capital reorganisation schemes lies with the Minister of Fuel. Prof. Beacham then referred to the disappointment of expectations that nationalization would inaugurate a new era in industrial relations in the industry. The reasons for this are deep-seated, but two points have been generally overlooked. First, the men, with long and bitter experience of over-production behind them, are unlikely to respond to the call for increased productivity on the facts as presented to them; and secondly, the antiquated, anomalous and almost unintelligible wages structure of the industry is a prolific cause of friction between management and men.

On price policy, Prof. Beacham emphasized the fundamental importance of proper grading of coals, and suggested that economists, chemists and geologists would need to put their heads together before these problems could be solved. In conclusion, he entered a plea for lower output targets in the next few years. High output targets are responsible for keeping costs and prices high, and signs are not lacking that Great Britain may have difficulty in disposing of her export surplus before the long-term technical reorganisation programme has produced any marked effect.

Mr. Dryden agreed with the general tenor of the preceding remarks and underlined the possibility of high costs and prices, together with competition, permanently restricting the demand for coal. As a measure of insurance against this, and (taking a shorter-term view) as a means of introducing flexibility and possibly reducing the price of fuel while maintaining or increasing the gross revenue from a ton of coal, he suggested that a greater proportion of scientific research in the coal industry should be directed towards the establishment of new chemical industries based on direct production (that is, using coal, not carbonization products) from low-grade coal residues, at present discarded. Such industries could also process a small proportion of the salable output in times of reduced demand. Mr. Dryden emphasized that coal is a complex organic substance of largely unknown constitution. A knowledge of its constitution would greatly accelerate progress, yet very little is being done. Advantage should be taken of this complex chemical nature by endeavouring to produce under mild and controlled conditions substances which are expensive to synthesize from petroleum. The biggest potential market probably lies in the field of constructional materials. Export of high-priced coal products in preference to raw coal should be encouraged when conditions allow; preparation should be made for sacrificing part of the fuel load to other sources of power in order to conserve our relatively meagre resources—compensation for this being sought in alternative markets for the new chemical products. Mr. Dryden advocated a flexible

balance of activity between coal production and chemical processing of coal in order to maintain an appropriate balance between demand and supply. Pointing out that such measures could not in themselves solve the problems of the industry, he estimated, nevertheless, that a very valuable contribution is possible.

The vital importance of a thorough investigation of the actual resources in Britain of the various types of coal was emphasized by Prof. Hickling. In the 'rapid survey' recently made by the Fuel Research Department, these were classified into nine main groups, based on their volatile yields and coking properties. The broad result of the survey was to show that, while the reserves of nearly all types are likely to last for another century, and some for substantially longer, the outlook is very different when the various coalfields are considered individually. In the North-Eastern coalfield the best metallurgical coking coals, practically confined to this field, are likely to be exhausted within fifty years. The coals in this and other fields show systematic area variation in composition, so that as different areas are exhausted the general character of the coal produced must change progressively. The valuable anthracites and low-volatile steam-coals, of which our known resources are practically confined to a portion of the South Wales field, are likely to be exhausted before other types from that field.

Prof. Hickling specially stressed the fact that while the proved coal resources of Great Britain give no ground for concern as to the immediate future, we cannot justify their continued exploitation without the fullest assessment of their extent and the probable duration of various types in different areas. The relatively large area of exposed and long-known coalfields, along with other circumstances, has long delayed attempts to locate possible buried coalfields which may yet be found. Modern methods of geophysical survey, elaborated in the search for oil, can now be applied to localize this problem and to prepare the way for final investigation by boring. This is a project of urgent importance.

Every coal is a complex mixture of substances of widely differing properties. Some of these may be separated with relative ease, others only with greater difficulty. There is a wide field for investigation of the economic possibilities of the preparation of coals on such lines, either for their use as special fuels or as raw materials. Blending of coals or of their separated components also demands development. In Great Britain little attention has been paid to the fact that at any point the deeper coals are in general of higher carbon content than those above. As mining is necessarily being driven deeper, this in turn must have an influence on the average quality of future products.

The final speaker, Mr. Maclean, refused to take a pessimistic view of the future of the industry, and declared that he is satisfied that within the next decade the National Coal Board will be producing about 250 million tons of coal per annum. Costs could be cut by reorganising transport arrangements so that a higher proportion of the available manpower may be concentrated at the face. He then referred to the very high average age of the present labour force in the mines, and stressed the need for stimulating juvenile recruitment. In this connexion, the Board has adopted a plan which should make mining a more attractive occupation to young entrants. In future, when a boy enters the industry, an assessment of his potentialities will be made at the end of his statutory training. If suitable, he will pass on at the age of sixteen to receive a course of general instruction in mining, and at eighteen will specialize in mechanics, electricity, surveying and mine management. Beyond this stage, scholarships will be available to take the best men on to the university. Mr. Maclean is satisfied that as these plans bear fruit the industry will prosper, and the country will not regret the decision to organise it on national lines.

A. BEACHAM

OBITUARIES

Prof. Major Greenwood, F.R.S.

MAJOR GREENWOOD, professor emeritus of epidemiology and vital statistics in the University of London, died on October 5 as he was about to take the chair at a meeting of the Cancer Research Committee. He was sixty-nine. His father, Dr. Major Greenwood, was a general practitioner in north-east London, a man of many parts interested in the humanities. From him Greenwood inherited literary tastes and a love of the countryside, particularly Epping Forest, where he lived for more than forty years, at Loughton. He used to recall with pleasure long cycle rides taken as a boy with his father in Essex and a holiday in Skye. I had known him for forty-five years at work and at leisure.

Greenwood was educated at the Merchant Taylors' School, of which he always spoke with affection, on the classical side, and there obtained a sound training in mathematics, to be extended later by private reading in the midst of many other activities. Nor did he let the classics slide. In later life he read early Latin texts of medical writers unaided, though he relied on his friend and colleague, Dr. May Smith, when reading obscure and un-Attic Greek texts.

From school he entered the London Hospital Medical College, qualified M.R.C.S., L.R.C.P. in 1904, and remained there as demonstrator in physiology, under Prof. Leonard Hill, until 1910. His first book, "The Physiology of the Special Senses", was published in that year. During those years he also studied with Prof. Karl Pearson at the Biometrical Laboratory at University College, and learnt the then new technique of mathematical statistics applied to natural selection in man, a technique he was to employ later with brilliant results in his own chosen fields of vital statistics and epidemiology. In 1910 Greenwood was appointed statistician to the Lister Institute, and remained attached to the Institute until he was asked to take charge of medical statistics at the newly created Ministry of Health in 1919; but for the last two years of the First World War he was seconded to take charge of the medical research section of the Ministry of Munitions. His work during that period on the frequencies of repeated accidents among munition workers, done in collaboration with G. Udny Yule, was based on an application of a generalized Poisson series; it became a classic and inspired fundamental work later by his colleagues, Newbold and Soper, at the School of Hygiene, and applications by the staff of the Industrial Health Research Board.

Greenwood left the Ministry of Health in 1928 to become the first professor of epidemiology at the London School of Hygiene and Tropical Medicine, a

post which he held until his retirement under the age limit in 1945. This period included, among many other activities, his long collaboration with the late Prof. W. W. C. Topley, in research in experimental epidemiology. In this work mice, whose allotted span is three score and ten days rather than years, took the place of men. A healthy colony of mice, would have added to it at predetermined intervals controlled proportions of mice inoculated with virus diseases capable of producing epidemics. Controlled numbers of healthy 'immigrant' mice were added from time to time. Fluctuations in the numbers of affected individuals as the number of susceptibles was reduced by death, and a study of the relevant life-tables, were used as models for the rise and fall of epidemics in human communities, with the technical advantage that two or three years covered many generations.

Greenwood was chairman of the Statistical Committee of the Medical Research Council from its inception until 1948, for many years a member of the Senate of the University of London, of many of its committees and of the Board of Studies in Statistics. His connexion with the Royal Statistical Society was long and intimate: fellow in 1909, joint honorary secretary 1919–34, president 1934–36, Guy Medal in silver in 1929, Guy Medal in gold—a rare distinction—in 1945. To the list of honours and distinctions must be added the conferment of the F.R.C.P. in 1924, D.Sc. London in 1928, the Buchanan Medal of the Royal Society in 1927, and election to the fellowship of the Royal Society in 1928, Arris and Gale Lecturer at the Royal College of Surgeons during 1907–8, and Milroy Lecturer at the Royal College of Physicians in 1922.

The scientific importance of Greenwood's work was recognized at home and abroad. At home he was asked to give the Linacre Lecture at Oxford in 1943, and short courses on epidemiology at Cambridge. Abroad he became one of the limited number of English members of the Institut Internationale de Statistique, and co-editor of *Metron*. He was appointed Herter Lecturer at Baltimore in 1931, choosing "Epidemiology, Historical and Experimental" for his subject. Most of the above lectures were published in book form. He also published in 1921, with Prof. E. L. Collis, "The Health of the Industrial Worker". Though Greenwood published many papers, particularly in *Biometrika* and the *Journal of the Royal Statistical Society*, much of his work is buried in reports to the Ministry of Health, and the published work of his colleagues and pupils owed much to his inspiration and advice.

The persecution of scientific workers and of freedom of thought, in any quarter, touched Greenwood to the quick. From 1933 onwards he was an active supporter of the Academic Assistance Council, later the Society for the Protection of Science and Learning, and acted as its treasurer. He helped many exiled scientific men to find an opportunity of continuing their work in Great Britain.

Greenwood's scientific work was characterized by the fact that, though he was not a professional mathematician—he always spoke of doing 'sums'—he had a sound mathematical instinct. In this his closest parallels were Faraday in electricity and magnetism, and in his own subject, Graunt and Farr. His mathematician friends were often asked by him to supply a mathematical proof of what Greenwood felt the figures must mean, and almost invariably his intuition was right. He had a tenacious memory and could quote Shakespeare and Heine unhesitatingly. Greenwood was a brilliant conversationalist. He will be missed in many circles, but nowhere more than at the centenarian Statistical Dining Club.

He married in 1908. The loss of his wife in 1945 was a blow from which he never recovered. He leaves two sons.

L. ISSERLIS

Sir Herbert Read, G.C.M.G., C.B.

By the death of Sir Herbert James Read on October 16, tropical medicine has lost one of its best friends and supporters, and his name is interwoven with the history of that branch of medicine. Born in 1863 and educated at Allhallows School, Honiton, he entered the Colonial Office as a higher-division clerk; but soon, by his assiduity, tact and industry, he rose, step by step, until he became assistant private secretary to Mr. Joseph Chamberlain, then Colonial Secretary, at the height of his career (1896). At this time Chamberlain had been gravely concerned about health conditions in West Africa. It was through Read's instrumentality that the name of Patrick Manson was brought to Chamberlain's notice, and this historic association between these two pioneers began. "His attention," so wrote the Colonial Secretary, "was definitely directed towards the importance of scientific enquiry into the causes of malaria and of special education in tropical medicine for the medical officers of the Crown Colonies."

Thereupon a subcommittee was appointed, consisting of H. J. Read and others, and this soon resulted in the foundation of the London School of Tropical Medicine at the Albert Docks on Manson's fifty-fifth birthday, on October 3, 1899. It was clear that the work could not stand still, and further funds were needed. This culminated in the appeal of Sir Austen Chamberlain in 1905. In all these matters Read was most active, through his innate powers, almost amounting to genius, as a committee man. Another boon to tropical medicine and tropical workers all the world over was the foundation of the Tropical Diseases Bureau in 1908, of which he was an active member of the Management Committee, supervising the production first of the *Sleeping Sickness Bulletin*, then of the *Tropical Diseases Bulletin* and, more recently, of the *Bulletin of Hygiene*. In 1921 Sir Herbert Read was elected an honorary fellow of the Royal Society of Tropical Medicine and Hygiene, and he was active afterwards in the establishment of Manson House as the headquarters of the Society. Read joined the Committee of Management of the Seamen's Hospital Society—the body most closely associated with tropical medicine in London—in 1898 and was a vice-president of the Society at the time of his death. He was also interested in the sister School of Tropical Medicine in Liverpool, of which he was a vice-president.

In all matters connected with the health of Colonial officials, Sir Herbert Read took the keenest interest, a fact of which consultants to that Department soon became aware. In the more particular matters of research he was also well versed. During 1924–30 Read was governor of Mauritius, and during his term of office great sanitary reforms were instituted, so that he had ample opportunities of becoming acquainted at first hand with the scourges of malaria, in particular, which he had formerly studied in Blue

Books. He served as British delegate at various international congresses dealing with African affairs, and for his great services he was created G.C.M.G. in 1935. In his retirement he continued to take a great interest in public matters, becoming chairman of the Executive Committee of the Imperial College of Science and Technology. In spite of the appearance of natural shyness, Read had a lovable nature and his associates were deeply attached to him.

PHILIP MANSON-BAHR

WE regret to announce the following deaths:

Mr. J. E. Barnard, F.R.S., formerly head of the Department of Applied Optics, National Institute for Medical Research, on October 25, aged eighty.

PROF. T. SLATER PRICE, O.B.E., F.R.S., emeritus professor of chemistry at the Heriot-Watt College, Edinburgh, formerly director of research to the British Photographic Research Association, on October 29, aged seventy-four.

NEWS and VIEWS

Proposed Institute of Biology

THE following have accepted invitations to join the provisional council of the Institute of Biology under the chairmanship of Dr. E. Hindle: Prof. E. Ashby, Prof. T. A. Bennet-Clark, Prof. G. E. Blackman, Mr. L. J. F. Brimble, Prof. J. F. Danielli (hon. secretary), Dr. D. G. Davey, Captain C. Diver, Dr. J. W. Evans, Prof. W. Graham, Prof. J. Gray, Prof. A. Haddow, Dr. J. Hammond, Dr. C. Horton-Smith, Prof. W. H. Pearsall, Mr. N. W. Pirie and Dr. F. S. Russell. The first general meeting of the Institute will be held in London on January 6, 1950, at 6 p.m. Agenda papers will be sent to all those who have already indicated their willingness to support the new Institute. Biologists who may not have received a copy of the memorandum outlining the proposed form of this Institute are invited to obtain it from Dr. R. J. C. Harris, Assistant Secretary, Institute of Biology, at the temporary office, Chester Beatty Research Institute, Royal Cancer Hospital, Fulham Road, London, S.W.3.

Zoology at Belfast: Prof. R. A. R. Gresson

THE vacancy in the chair of zoology at Queen's University, Belfast, created by the retirement of Prof. T. T. Flynn (see *Nature*, July 24, 1948, p. 135), has been filled by the appointment of Dr. R. A. R. Gresson, who took over the duties of the chair at the opening of the present session. Since 1931, Dr. Gresson had been lecturer in cytology in the Department of Zoology, University of Edinburgh, where he had risen to the grade of senior lecturer and deputy head of the Department. Previously he had been assistant lecturer in the Department of Natural History, University College, Dundee, whither he proceeded after preliminary training in the Royal College of Science and Trinity College, Dublin, and graduation at the University of Edinburgh. Dr. Gresson's cytological research has been concentrated upon the description of the changes which take place in the extra-nuclear components of cells, and the elucidation of these changes, particularly in relation to developing germ cells and induced changes in secretory activity. His recent volume, "Essentials of General Cytology", published by the Edinburgh University Press (1948), is a text-book the conciseness and the illustrations of which will be appreciated by university teachers and their students.

Long-distance Test Flight of Jet-Propelled Air Liner

A DE HAVILLAND 'Comet' jet-propelled air liner recently carried out a long-distance flight, as part of its trials, from London to Castel Benito, Tripoli, a distance of 2,980 miles in a total flying time of six hours thirty-eight minutes—an average speed of just over 450 miles an hour. This is more than 100 miles an hour faster than the authenticated speed of any established air liner at present in use. It left London at 6.30 a.m. and, after a two-hour period in Tripoli for refuelling, it arrived back in London at 4 p.m. A performance such as this suggests that this type of machine should be taken up immediately by air transport concerns everywhere. Quantity production is already in hand by Messrs. De Havilland; but it is not expected that they will be operating on the trunk services of the British Overseas Airways Corporation until 1952–53.

The reason for this delay is twofold, neither cause being within the scope of the aircraft designer to alter. The high fuel consumption of the internal combustion turbine means that only a small margin of fuel can be carried in reserve for these long-distance flights. Upon arrival at a crowded airfield, they are consequently unable to cruise around waiting for their turn to land, as is quite normal practice on popular routes to-day. The technique of airfield control will have to be altered to suit these different conditions, and as such changes will need to be international, there must be a period of investigation and discussion before agreement will be reached. Further, unless these machines, or others of similar performance, are available to foreign air lines, they are not likely to be interested in the immediate changing of their airfield control. The second problem is a meteorological one. Jet-propelled aircraft must fly at considerable heights to ensure economical flight conditions, and there is still a lack of precise knowledge of the wind speeds and directions in the upper atmosphere. It is known that these winds are strong enough to produce serious navigational errors if not allowed for, and apart from the question of difficulty of time-keeping to a schedule in such circumstances, the small fuel reserve carried means that a dangerous situation would arise if the machine was blown far off its intended course.

Reindeer Council of the United Kingdom

THE Reindeer Council of the United Kingdom came into existence recently in response to the interest aroused, both in Scotland and in England, in a proposal to introduce reindeer in some suitable area of the United Kingdom. The founders of the Council include travellers, explorers and arctic experts who are concerned to develop national and Commonwealth resources to the full at this critical time, an addition to the present inadequate supply of meat and hides being one of their aims; the chairman of the Council is Sir Frederick Whyte. The Council is pledged to

encourage experiments in reindeer-breeding in suitable areas in Scotland and/or elsewhere in the United Kingdom and overseas, and to engage in any appropriate activity ancillary thereto. The immediate concern of the Council is to take advantage of an offer of twenty-five first-class breeding and draught animals from Scandinavia, which would be transported to the British Isles and cared for by trained herders for a minimum of three years, without cost to Great Britain. The offer was made in response to the interest shown, especially by Scots, in the economic possibilities of domesticated reindeer. The honorary secretary to the Council is Dr. E. J. Lindgren, Annesley House, 1*a* Union Road, Cambridge. Purely from the biological point of view, and as an experiment, the generous offer of twenty-five reindeer made to the Council is of considerable interest, provided that a suitable area can be found where the animals would have an opportunity of flourishing without disturbing seriously the native fauna, and that adequate measures to prevent their escape over the countryside are taken.

Russian Periodicals : Translated Contents Lists

SINCE September 1947, the use of Western European languages in periodicals has ceased in the U.S.S.R. Prior to that time the lists of contents in many periodicals were translated into English, French and German, while some of the periodicals, such as the *Journal of Physics*, were published entirely in Western European languages. In attempts to make known the contents of Russian periodicals, many organisations have been translating contents lists for their own internal use. Recently, the Department of Scientific and Industrial Research started a scheme for collecting these lists and publishing them at monthly intervals under the title of "Translated Contents Lists of Russian Periodicals". The first issue appeared in June 1949. The original typescripts are used to make rota-print plates photographically, and it may be partly due to this that the booklet appears to be more up to date than two similar publications appearing in the United States. About a hundred Russian scientific and technical periodicals are available for export to Great Britain, and the publication of the Department covers some seventy of these in all fields, including agriculture and medicine. Copies of the "Translated Contents Lists of Russian Periodicals" are circulated free of charge to all co-operating organisations and, so far as the supply will permit, to other research organisations. If the demand becomes much greater, it may be necessary to charge for copies. A list of the periodicals not at present covered by the scheme is available, and anyone interested in helping to make this publication complete is invited to write to the Secretary, D.S.I.R. (Intelligence 1), Dorland House, 14–16 Regent Street, London, S.W.1.

Centre for Studies and Documentation in Palæontology, Paris

THE Muséum d'Histoire Naturelle in Paris has set up a Centre for Studies and Documentation in Palæontology to provide, in the form of microfilm, photocopy or letter, information and bibliographical or systematic references on the following subjects : (1) General information about the different sciences of the earth ; for example, details about the location of extensive collections of geological or stratigraphical terms, etc. (2) Bibliographical information on the different sciences (mineralogy, petrography, tectonics, geophysics, applied geology, regional geology, stratigraphy, general palæontology, biological questions of interest to the palæontologist). (3) References and figured slips dealing with animal and plant systematics in general (bibliographies, lists of types, lists of genera and higher groups, systematic groupings). In addition to palæontological study, collections of the Centre can be consulted on the spot. Information on the above subjects is obtained by regular analysis of some 2,500 journals. Special studies can also be made, on request, for the period prior to 1940 or on any particular subject. The Centre also undertakes summaries of various articles, translations of articles published in Russian or Polish, and the preparation of figures of type-specimens in old collections. These documents are listed as they are completed in a small three-monthly bulletin. The use of the Centre is open to all, and in addition members (annual subscription of 300 fr.) receive the bulletin free of charge and can obtain reproductions at special rates. All inquiries should be addressed to : Prof. Roger, Centre d'Études et de Documentation Paléontologiques, 3 Place Valhubert, Paris 5. Payments should be made to Syndicat de Documentation Géologique et Paléontologique, 61 Rue de Buffon, Paris 5.

Transfer of Medical Books in the United States

THE New York Public Library has recently given twenty thousand medical volumes to the New York Academy of Medicine, these books being in the main the original collection accumulated by the Public Library during the nineteenth century when Dr. John Shaw Billings, earlier noted for his association with the Army Medical Library, was connected with it. This gift to the Academy of Medicine represents the fulfilment of an agreement entered into in 1910 between the Academy and the Public Library, whereby the former took over the medical part of the latter's library service. Since that time the Academy has served freely the needs of all in New York who have desired to consult medical literature, and it caters at present for about forty thousand readers a year. Of the twenty thousand volumes it has received, the Academy has decided to retain some eight thousand, adding them to its present collection of 260,000, and to give the remaining twelve thousand to the Southwestern Medical College in Dallas, Texas. This latter is a new College, founded in 1943, and is in the process of building up its library. Most of the larger medical libraries of the United States are located east of the Mississippi River, and it is highly commendable that the New York Academy of Medicine has made this contribution to the growth of a medical collection in the newer areas of the West.

Gresham's School Natural History Society

THE twenty-seventh report of Gresham's School Natural History Society once more shows the virility of these societies in our public schools. The report contains a list of the meetings and visits arranged by the astronomy, botany, entomology, meteorology and ornithology sections as well as a record of common and rarer plant, animal and other observations made during the year. The editor points with pride to two fine photographs of the American pectoral sandpiper (*Calidris melanotos*). This rare immigrant was first observed by one of the members of the Society in September 1948, and the photographs afterwards taken were the first to be obtained of this bird in the

British Isles and probably in Europe. There is also a record of an attempt, in which the boys of Gresham's School have played an important part, to establish a fulmar colony at Weybourne and another of a visit paid by members of the Society to Skokholm. Abridged reports of two prize-winning efforts in an essay competition deal with the birds of the Yealm Estuary in South Devon and a biological survey of a small stagnant pool, and show that Gresham's School is admirably contributing to the future supply of our field naturalists.

National Forest Parks

THE latest in the series of National Forest Park guides prepared by the Forestry Commission are those for Glen More in the Eastern Highlands of Scotland and Hardknott in south-west Cumberland. The one for Glen More has been edited by Prof. John Walton, who also describes the vegetation of the district. In two separate articles, A. Macpherson Grant and Miss I. F. Grant describe the history and traditions of the district, while descriptions of the geology and wild life are contributed by J. G. C. Anderson and Seton Gordon. Accounts are also given of the forests and plantations and the climbing grounds and hill walks in and around Glen More Park. J. M. Bannerman has provided a list of Gaelic place names and their translations, and there is a comprehensive bibliography. There are also a number of etchings, photographs and specially prepared maps, all of a quality which equals the high standard of the contributed articles. The guide for Hardknott has been prepared on a similar plan and reaches an equal standard of excellence. Five of these guides have now been published and may be obtained from H.M. Stationery Office, price 2*s*. each.

Diseases of *Lachenalia glaucina*

LACHENALIAS are grown rather sporadically in British horticulture. They have not hitherto been attacked by many fungal parasites; but D. E. Green and M. A. Hewlett describe a bulb rot and a leaf spot upon this host (*J. Roy. Hort. Soc.*, **74**, Pt. 5, 211; May 1949). The bulb rot is caused by a species of *Fusarium*, and *Mystrosporium adustum* is the parasite in leaf spot. Inoculation experiments have proved the pathogenicity of *M. adustum*, and have shown that it produces symptoms of ink disease on *Iris reticulata*.

Advisory Committee on Colonial Geology and Mineral Resources: Appointments

THE Secretary of State for the Colonies, Mr. A. Creech Jones, has appointed an Advisory Committee on Colonial Geology and Mineral Resources to advise him on matters relating to the geological survey of the Colonial Empire and the investigation of its mineral resources. The membership of the Committee is: Mr. C. G. Eastwood (*chairman*), Colonial Office; Mr. N. L. Mayle, Colonial Office; Dr. F. Dixey, geological adviser to the Secretary of State; Mr. E. S. Willbourn, Directorate of Colonial Geological Surveys; Mr. G. E. Howling, principal, Mineral Resources Division of the Colonial Geological Surveys; Sir Edmund Teale, formerly mining consultant to the Tanganyika Government and director of the Geologica Survey, Tanganyika; Sir Lewis Fermor, formerly director of the Geological Survey of India; Mr. R. Annan, chairman of various gold mining companies operating in Africa; Mr. S. H. Boileau, chairman of the Chrome Co., Ltd., and the African Manganese Co., Ltd.; Dr. C. H. Desch, director of the Iron and Steel Institute; Dr. J. G. King, director of the Gas Research Board; Mr. F. B. Howard White, Mond Nickel Co., Ltd.; Dr. W. F. P. McLintock, director of the Geological Survey of Great Britain; Sir Andrew McCance, president of the Iron and Steel Institute; Mr. B. Lightfoot, formerly director of the Geological Survey of Southern Rhodesia; Prof. A. E. Trueman, chairman, University Grants Committee; Prof. H. H. Read, professor of geology, Imperial College of Science and Technology, London; Dr. G. M. Lees, chief geologist, Anglo-Iranian Oil Co.; Prof. J. A. S. Ritson, professor of mining, Royal School of Mines, London; Mr. L. C. Hill, Rio Tinto Co., Ltd.; Sir William Ogg, director of Rothamsted Experimental Station; Mr. E. H. Beard (*joint secretary*), Mineral Resources Division of the Colonial Geological Surveys; Mr. R. H. Hobden (*joint secretary*), Production and Marketing Department "B", Colonial Office.

Royal Society of Edinburgh: Officers

THE following have been elected officers and members of council for 1949–50 of the Royal Society of Edinburgh: *President*, Prof. J. Kendall; *Vice-Presidents*, Sir Ernest Wedderburn, Prof. A. C. Aitken, Prof. E. P. Cathcart, Sir Alexander Gray, Prof. A. Holmes and Prof. W. O. Kermack; *General Secretary*, Dr. J. E. Richey; *Secretaries to Ordinary Meetings*, Prof. E. T. Copson and Prof. J. Norman Davidson; *Treasurer*, Mr. A. W. Young; *Curator of Library and Museum*, Dr. D. Guthrie; *Ordinary Members of Council*, Prof. J. H. Gaddum, Prof. G. D. Preston, Prof. S. J. Watson, Mr. R. Ll. Gwilt, Mr. E. G. Dymond, Mr. C. W. Parsons, Prof. R. W. Wheldon, Prof. T. Neville George, Prof. J. W. Heslop Harrison, Dr. C. E. Lucas, Prof. M. G. Say and Prof. W. M. Smart.

University of London

PROF. D. H. HEY, professor of chemistry at King's College, has been appointed to the Daniell chair of chemistry tenable at the College from October 1, 1950, in succession to Prof. A. J. Allmand, who will be retiring at the end of the session 1949–50. Dr. Forrest Fulton has been appointed to the University readership in bacteriology and immunology tenable at the London School of Hygiene and Tropical Medicine from October 1. The title of professor emeritus in the University has been conferred on Prof. C. A. Lovatt Evans on his retirement from the Jodrell chair of physiology at University College, to which he was appointed in 1926; and on Prof. C. B. Fawcett on his retirement from the chair of geography at University College, which he has held since 1928.

The following doctorates have been conferred: D.Sc. on R. A. Gregory (University College), and J. E. Webb (Birkbeck College); D.Sc. (Eng.) on A. J. Gould (external student), and A. W. Skempton (Imperial College).

ERRATUM. In the communication on "Adenosine Triphosphatase Activity . . ." by Dr. A. Csapó in *Nature* of October 22, p. 702, we regret that "triphosphatase" was printed instead of "triphosphate" in par. 1, line 13; par. 2, line 9; par. 3, line 5; par. 4, line 3.

RELATIONS BETWEEN ACETYLCHOLINE SYNTHESIS AND METABOLISM OF CARBOHYDRATES AND *d*-GLUCOSAMINE IN THE CENTRAL NERVOUS SYSTEM

By Dr. R. P. HARPUR* and Prof. J. H. QUASTEL, F.R.S.
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THE part played by carbohydrates in the synthesis of acetylcholine in animal tissues is at present far from clear. It was first shown by Quastel, Tennenbaum and Wheatley[1] that the formation of free acetylcholine by brain cortex slices is dependent upon respiration in a physiological medium containing either glucose, lactate or pyruvate, and later by Mann, Tennenbaum and Quastel[2] that a bound form of acetylcholine exists in brain tissue which is synthesized when brain respires in the presence of glucose, lactate or pyruvate. These authors pointed out that acetylcholine formation in brain slices was always high under those conditions which produce either a high aerobic glycolysis or a high respiration. They suggested the presence of a definite link between the two metabolic processes, one involving glucose breakdown and the other acetylcholine formation. It was further suggested that synthesis depends upon the absorption of energy supplied by oxidative reactions taking place during the combustion of glucose, lactate or pyruvate; but it was emphasized that, anaerobically, in presence of glucose when extensive glycolysis is taking place, little or no synthesis of acetylcholine occurs with brain slices or minced tissue.

The conclusion that glucose, or a breakdown product of glucose, is important for the synthesis of acetylcholine under physiological conditions received confirmation from MacIntosh's[3] perfusion experiments carried out on the cat's superior cervical ganglion. Later work by Mann, Tennenbaum and Quastel[4] showed that in contrast to glucose, the presence of fructose has but little effect in securing acetylcholine synthesis in respiring intact brain slices, a fact which may be correlated with the observation of Kahlson and MacIntosh[5] that fructose does not enhance acetylcholine production in perfused ganglia. The failure of fructose to secure acetylcholine synthesis in isolated brain at a rate comparable with that due to glucose requires explanation in view of the fact that fructose is almost as effective as glucose in maintaining the respiration of intact brain tissue[6].

Our knowledge of the mechanism of acetylcholine formation in nervous tissue was greatly extended when it was found by Nachmansohn and Machado[7] that a brain homogenate will synthesize acetylcholine under anaerobic conditions provided that adenosinetriphosphate and fluoride are added to the medium. Feldberg and Mann[8] showed that the synthesis will occur in cell-free extracts of acetone-dried brain under the same conditions.

These findings make it evident that the combustion of glucose under aerobic conditions in intact brain slices provides a sufficiently high concentration of adenosinetriphosphate for acetylcholine synthesis. Since it is well known that the conversion of glucose to lactate provides only a small fraction of the energy released by the complete aerobic breakdown of glucose, it is evident that the finding of Quastel *et al.*[1] that acetylcholine is not synthesized by brain slices under anaerobic conditions is satisfactorily explained by the assumption that the amount of adenosinetriphosphate synthesized is inadequate. It should be mentioned that Proger *et al.*[9] have shown that the adenosinetriphosphate concentration of heart and kidney is markedly reduced under conditions of anoxia.

In contrast to the virtual necessity of glucose for the synthesis of acetylcholine by slices, Feldberg and Mann[10] found that the presence of glucose, at concentrations similar to those in the blood, and also of fructose, strongly inhibits the synthesis of acetylcholine by extracts of acetone brain powders. As the inhibition is associated with a decrease in seven-minute hydrolysable phosphate, they suggested that it may be due to a loss of adenosinetriphosphate from the system owing to the phosphorylation of the sugar.

While the discovery of adenosinetriphosphate as an essential factor in the synthesis of acetylcholine makes obvious the importance of respiratory systems involving adenosinetriphosphate synthesis, the contrary effects of glucose on acetylcholine synthesis in the intact tissue and in the extracts require explanation. Again, it is remarkable that fructose, which is oxidized by brain and which, presumably, will give rise during its metabolism to adenosinetriphosphate enrichment of the brain, will not secure acetylcholine synthesis in slices and like glucose will inhibit acetylcholine synthesis in cell-free extracts. Since Meyerhof and Geliazkowa[11] have shown that the anaerobic glycolysis of fructose in brain extracts is dependent upon the substrate and adenosinetriphosphate concentrations, and since glycolysis of glucose takes place with brain extracts anaerobically at a much more rapid rate than with slices[12,13], it is possible that brain extracts may be made to produce sufficient adenosinetriphosphate from the glycolysis of glucose and fructose for the synthesis of acetylcholine. Results given in this paper show that under certain experimental conditions these expectations can be fulfilled.

Methods

Beef brains were obtained from the abattoirs within thirty minutes of the death of the animals. The grey matter was removed, suspended in its own volume of an ice-cold solution of nicotinic acid amide (0·16 *M*), cysteine hydrochloride (0·013 *M*) and disodium hydrogen phosphate (0·02 *M*). After mincing in a Waring blendor for thirty seconds the suspension was tipped into 10–20 volumes of ice-cold acetone. The resulting acetone-dried powder was filtered, washed with acetone and stored in a vacuum desiccator in the cold. It should be mentioned that the results recorded in this paper may be obtained with powders made by simply grinding the brain in ice-cold acetone, but the procedure outlined above is quicker and allows the preparation of larger quantities of acetone-dried powders.

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Experiments were carried out in Warburg manometer vessels, in an atmosphere of 93 per cent nitrogen 7 per cent carbon dioxide, and at a temperature of 27° C., gas evolutions being measured in the conventional manner. Acetylcholine determinations were made with the eserinized leech, but to minimize the sensitizing action of adenosinetriphosphate and other phosphate esters the following procedure was employed. At the conclusion of the experiment (1–2 hr.), the solution in the Warburg vessel (3 ml.) was poured into 2 ml. of 0·2 *M* NaH_2PO_4 and placed in a boiling water bath for ten minutes. After cooling, 2 ml. of 0·3 *M* $BaCl_2$ was added and the *p*H adjusted to 7 with saturated barium hydroxide. After centrifuging, the clear supernatant was decanted and the excess barium removed with sodium sulphate. If the solution was not assayed immediately, further dihydrogen sodium phosphate was added to lower the *p*H. It was shown that the entire procedure does not result in any loss of acetylcholine. The same solutions were used for the estimation of lactate by the method of Barker and Summerson[14]. Due provision was made, in all analyses, for the acetylcholine and lactate initially present.

Inhibitory Effects of Glucose and Fructose on Acetylcholine Synthesis

The acetone-dried brain was extracted with a solution of sodium chloride and neutralized cysteine hydrochloride. After centrifuging, 1·5 ml. of the opalescent centrifugate, corresponding to an extract of 60 mgm. of the dry powder, was placed in each vessel together with a solution of salts, the final volume being 3·0 ml.

The final concentrations of salts were as follows: 0·078 *M* NaCl, 0·017 *M* cysteine, 0·047 *M* $NaHCO_3$, 0·027 *M* KCl, 0·004 *M* $MgSO_4$, 0·0008 *M* choline chloride, 0·0083 *M* trisodium citrate, 17 mgm. per cent eserine sulphate, and sugar at appropriate concentration. A neutral solution of adenosinetriphosphate (final concentration 0·002 *M*) was placed in the side-tube and tipped after equilibration and gassing.

Table 1

Action of glucose, fructose, *d*-glucosamine and *N*-acetylglucosamine on CO_2 evolution and acetylcholine synthesis by acetone-dried beef brain extracts

(Bicarbonate–citrate–cysteine–fluoride medium; 27° C.; Na_4 adenosinetriphosphate (final concentration 0·002 *M*) tipped from side-tube after 30 min. equilibration.)

Expt.	Substrates added	Microlitres CO_2 in 60 min./vessel	Micrograms acetylcholine/gm. powder in 120 min.
1.	Nil	6	162
	Glucose 0·01 *M*	150	42
2.	Nil	33	190
	Glucose 0·002 *M*	101	36
3.	Nil	50	150
	Fructose 0·001 *M*	130	50
4.	Nil	50	150
	d-Glucosamine 0·001 *M*	75	40
	N-Acetylglucosamine 0·004 *M*	53	120
5.	Nil	12	240
	d-Glucosamine 0·001 *M*	59	56
	N-Acetylglucosamine	18	166
	d-Glucosamine 0·001 *M* + *N*-Acetylglucosamine 0·004 *M*	28	100
6.	Nil	12	240
	Fructose 0·001 *M*	121	67
	N-Acetylglucosamine 0·004 *M*	18	166
	Fructose 0·001 *M* + *N*-Acetylglucosamine 0·004 *M*	46	134
7.	Nil	38	155
	Glucose 0·001 *M*	105	35
	Glucose 0·001 *M* + *N*-Acetylglucosamine 0·004 *M*	112	40

Using this procedure, results were obtained which show the inhibitory action of glucose and fructose on acetylcholine synthesis and confirm the results of Feldberg and Mann[9,10]. Typical results are shown in Table 1. At the same time it is clear that, whenever inhibition occurs, there is a large increase in carbon dioxide output. This is due to the phosphorylation of sugar at the expense of adenosinetriphosphate, an additional ionizable hydrogen ion being formed on phosphorylation which, reacting with the bicarbonate medium, liberates carbon dioxide. This phenomenon is the basis of the manometric technique of Colowick and Kalckar[15], which has been used for the study of the kinetics of the phosphorylations of glucose and fructose, etc., in beef brain extracts[16,17].

The correlation between hexose phosphorylation in presence of adenosinetriphosphate and hexose inhibition of acetylcholine synthesis makes it likely that the fall in adenosinetriphosphate concentration is responsible for the fall in acetylcholine synthesis. This hypothesis can be tested by making use of the finding that *d*-glucosamine may be phosphorylated by brain extracts at the expense of adenosinetriphosphate[17].

Inhibition of Acetylcholine Synthesis by *d*-Glucosamine

Experiment shows that *d*-glucosamine exerts an inhibition of acetylcholine synthesis in an extract of acetone-dried brain powder at concentrations similar to those at which glucose or fructose exert their inhibitions. Typical results are shown in Table 1. At the same time there is an increased carbon dioxide evolution due to phosphorylation of *d*-glucosamine.

Relief of Inhibition by N-Acetylglucosamine

Harpur and Quastel[17] showed that N-acetylglucosamine competes with *d*-glucosamine and with fructose for the phosphorylase involved in the reaction with adenosinetriphosphate; but that *N*-acetylglucosamine is not itself phosphorylated. Thus in suitable concentrations N-acetylglucosamine prevents the dephosphorylation of adenosinetriphosphate by *d*-glucosamine or by fructose, and should relieve the inhibition of acetylcholine synthesis. Experimental results, some of which are shown in Table 1, are in accordance with this prediction. The affinity of fructose is of the same order as that of *d*-glucosamine for the phosphorylase concerned, and it was found that *N*-acetylglucosamine has a relieving action on fructose inhibition of acetylcholine synthesis similar to that on the *d*-glucosamine inhibition. The affinity of glucose for the phosphorylase far exceeds that of fructose or *d*-glucosamine, and under the experimental conditions so far employed, little or no relieving action of *N*-acetylglucosamine has been found with glucose inhibition of acetylcholine synthesis. *N*-acetylglucosamine, though not phosphorylated, exerts a small but definite inhibition on acetylcholine synthesis on its own account. The reason for this is not yet known, but it may be due to a specific interference with the process of acetylation of choline.

The marked relieving action of *N*-acetylglucosamine on the inhibition of acetylcholine synthesis by fructose or *d*-glucosamine is the first example of its kind. The fact that it was predicted from phosphorylation studies gives increased confidence in the hypothesis that inhibition of acetylcholine synthesis

in brain extracts by carbohydrates is due to phosphorylations at the expense of the adenosinetriphosphate.

Effect of Nicotinic Acid Amide on Acetylcholine Synthesis in Cell-Free Brain Extracts

For these manometric studies the following concentrations of salts were used: 0·047 *M* $NaHCO_3$, 0·007 *M* sodium phosphate buffer *p*H 7·5, 0·028 *M* KCl, 0·004 *M* $MgSO_4$, 0·0008 *M* choline Cl, 17 mgm. per cent eserine sulphate, and 0·0008 *M* Na_4ATP. Each vessel contained a total volume of 3 ml. and the amount of extract was equivalent to 60 mgm. brain powder.

An extract of acetone-dried brain, made with sodium chloride solution (final concentration 0·052 *M*) or with a neutral cysteine solution (final concentration 0·011 *M*), when added to the above medium with glucose (0·017 *M*) showed little or no glycolysis or acetylcholine formation, as illustrated in Table 2. The absence of any appreciable synthesis

Table 2

Effects of nicotinic acid amide on glycolysis and acetylcholine formation in extracts of acetone-dried beef brain (Bicarbonate–glucose–phosphate medium; 0·0008 *M* Na_4 adenosinetriphosphate; 27° C. Time of experiment, 1 hour plus 15 minutes equilibration.)

Substances added to extraction soln. (final concentration)	Micromoles CO_2	Micromoles Lactic acid	Micrograms acetylcholine/gm. powder in 60 min.
Cysteine (0·011 *M*)	0	3·3	18
Cysteine (0·011 *M*) + Nicotinic acid amide (0·033 *M*)	17·5	28·1	156
Sodium chloride (0·052 *M*)	0	1·5	1
Nicotinic acid amide (0·033 *M*)	16·7	—	67
Cysteine (0·011 *M*) + Sodium chloride (0·052 *M*)	0	—	25
Cysteine (0·011 *M*) + Nicotic acid amide (0·033 *M*) + Sodiunm chloride (0·052 *M*)	12·9	16·7	156

of acetylcholine may be attributed to the presence of the sugar and to the absence of citrate, since citrate has a relative large activating action on the synthesis of acetylcholine by non-glycolysing beef brain extracts. It should be pointed out that Ochoa[18] has shown that acetone-powder extracts contain very little adenosinetriphosphatase activity.

When nicotinic acid amide (final concentration 0·033 *M*) is added to the extracting solution, an entirely different picture presents itself.

A cysteine–nicotinic acid amide extract of an acetone-dried brain powder produces in the presence of glucose and of adenosinetriphosphate a comparatively high rate of glycolysis and a high rate of acetylcholine formation. Even in the absence of cysteine, a nicotinic acid amide–sodium chloride extract raises the acetylcholine formation, in the presence of glucose, from 1 microgram per gram to 67 micrograms. The presence of cysteine more than doubles this rate of synthesis. All these results are shown in Table 2. It will be noted that the synthesis of acetylcholine is taking place in the presence of a concentration of glucose which previously has been shown to be inhibitory. It will also be noted that no diphosphopyridinenucleotide was added.

The increase in the rate of glycolysis, which is closely associated with the acetylcholine synthesis, is shown in Table 2, both by the carbon dioxide evolution and by the lactic acid formation. It should be mentioned that in Table 2 no subtraction has been made for the lactic acid formation during the fifteen-minute equilibration period.

The effect of nicotinic acid amide in securing a synthesis of acetylcholine under conditions where, in its absence, the synthesis does not occur is not difficult to explain. Phosphorylation of glucose to hexosediphosphate takes place, but further metabolism past the triosephosphate stage will only obtain in presence of diphosphopyridinenucleotide. Brain extracts contain an active diphosphopyridinenucleotidase which is inhibited by nicotinic acid amide[19]. Thus, the accelerating action of nicotinic acid amide on acetylcholine synthesis may be attributed to its ability to preserve diphosphopyridinenucleotide which by enabling glycolysis to take place causes adenosinetriphosphate to be produced at a rate comparable with the rate of its breakdown. Meyerhof and his associates[11,20], have discussed the part played by adenosinetriphosphatase in maintaining high rates of glycolysis, and although our experiments have been directed to establishing a relationship between glucose metabolism and acetylcholine synthesis in extracts low in adenosinetriphosphatase, it should be remembered that in the intact cell this enzyme must play an important part.

Effect of Fructose on Acetylcholine Synthesis

It is to be emphasized that the anaerobic system which we have described above is dependent upon glucose for the relatively high rate of acetylcholine synthesis. It can be seen in Table 3 that in the

Table 3

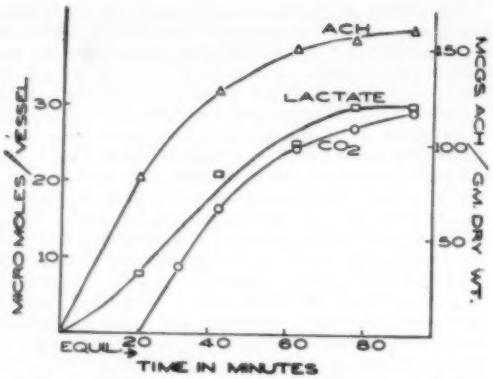
Acetylcholine synthesis and glycolysis in the presence of glucose and fructose in cysteine–nicotinic acid amide extracts of acetone-dried beef brain powder (Bicarbonate–glucose–phosphate medium; 0·001 *M* Na_4 adenosinetriphosphate. 27° C. Time of experiment, 1 hr. plus 15 min. equilibration)

Expt.	Substrate	Micromoles CO_2 after 15	30	60 min	Micrograms acetylcholine/gm. powder in 60 min.
1.	Nil	0·7	0·7	0·7	20
2.	Glucose 0·006 *M*	11·7	15·7	19·6	100
	Glucose 0·27 *M*	12·8	24·2	38·0	170
	Fructose 0·27 *M*	18·5	30·0	37·0	100
	Fructose 0·017 *M*	18·7	30·0	37·1	100

absence of glucose only a very small synthesis takes place, whereas even 0·006 *M* glucose increases the synthesis five times. It can also be seen in Table 3 that fructose, which in the concentrations shown, produces a higher rate of glycolysis, can replace glucose for the synthesis of acetylcholine. This is the first time that fructose has been shown to be capable of assisting acetylcholine synthesis. The effects of different concentrations of sugars will form the subject of a later communication.

Glycolysis and Acetylcholine Synthesis

The results shown in the accompanying graph demonstrate that the rate of acetylcholine formation in a nicotinic acid amide–cysteine extract of acetone-dried brain, in the presence of glucose, phosphate and adenosinetriphosphate closely follows the rate of glycolysis. This is to be expected if the view be correct that in an extract in which glycolysis proceeds under optimal conditions, the rate of adenosinetriphosphate formation is at least equal to the rate of its breakdown; this would secure both a constant rate of glycolysis and a constant rate of acetylcholine synthesis. The failure of earlier investigators to observe marked synthesis of acetylcholine in a cell-free extract in the presence of sugars (and the absence



Rates of formation of acetylcholine (*ACH*), production of lactic acid and evolution of carbon dioxide in cell-free brain extracts. Experimental conditions as described in text. Equil. = equilibration period

of fluoride) is due to the fact that precautions were not taken to preserve the diphosphopyridine nucleotide present. It may be concluded that the integrity of the diphosphopyridine nucleotide carrier system is essential, in the intact cell, for optimal rates of acetylcholine synthesis.

Conclusion

The results given in this preliminary account of the relations existing between carbohydrate metabolism and acetylcholine synthesis suggest that, in the intact tissue, diphosphopyridine nucleotide is linked with acetylcholine formation through the dependence of adenosinetriphosphate synthesis upon an intact diphosphopyridine nucleotide system; certainly in these studies with extracts, both factors are equally involved in the production of acetylcholine. It has been shown for the first time that *d*-glucosamine inhibits acetylcholine synthesis in non-glycolysing cell-free extracts and that the presence of *N*-acetylglucosamine counteracts the inhibitory effects of *d*-glucosamine and fructose on acetylcholine synthesis. These results are predictable from the facts that *d*-glucosamine is phosphorylated by adenosinetriphosphate in a brain extract and that *N*-acetylglucosamine is a competitive inhibitor to *d*-glucosamine and fructose. It is shown also that both glucose and fructose will secure acetylcholine synthesis in a cell-free brain extract in the presence of adenosinetriphosphate, the necessary condition being that nicotinic acid amide is present in the extraction medium to preserve the presence of diphosphopyridine nucleotide. It is also shown that the course of acetylcholine synthesis under these conditions is parallel to that of lactic acid formation. It follows from these facts that the synthesis of acetylcholine, dependent upon an optimal concentration of adenosinetriphosphate, requires in the cell an optimal rate of formation of diphosphopyridine nucleotide to compensate for diphosphopyridine nucleotidase and other activities which might result in the loss of diphosphopyridine nucleotide from the cell. It also follows that any circumstances, physical or chemical, which will interfere adversely with the activity of the diphosphopyridine nucleotide carrier system or with the synthesis of adenosinetriphosphate in the cell, will also have an adverse effect on the synthesis of acetylcholine.

Our thanks are due to Miss Powell and Miss Magor for their assistance in the lactic acid estimations. We are much indebted to the National Cancer Institute of Canada for a grant in aid of this work.

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PROJECTION TELEVISION

A DEMONSTRATION was given in London recently of the projection of received television pictures on to a screen measuring 4 ft. by 3 ft., a size which is intermediate between the conventional direct-viewing home receiver using a cathode ray tube from 9 in. diameter upwards, and the full-size public cinema screen. The demonstration was arranged by Messrs. Philips Electrical, Ltd., and indicated the commercial possibilities of a television projection set giving pictures comparable with those obtained with a good-quality 16-mm. cinema projector. It is estimated that some seventy people can view the picture in comfort.

This development is the outcome of research initiated in the Philips' Laboratories in Eindhoven, and some of the technical features of the equipment have been described in the *Proceedings of the Institute of Radio Engineers, N.Y.*, **36**, 395, March 1948, and in various papers in *Philips Technical Review* during 1948–49. The apparatus consists essentially of a television receiver of the orthodox type, and an optical unit, which comprises a cathode ray tube with a 2½-in. diameter screen and a Schmidt projection system. In order to obtain adequate brightness in the enlarged picture, a very high intensity is required on the fluorescent screen of the cathode ray tube, and this is secured by a high-velocity electron stream with a 25,000-volt supply. An interesting feature of the set is that the supply unit for this voltage is very compact, being about 5 in. square by 7 in. high. This small size has been achieved by the use of 'Ferroxcube' for the core of the transformer, and the enclosure of this high-voltage coil with its rectifier diodes and filter capacitors in a metal can filled with transformer oil, the whole assembly being impregnated under vacuum and afterwards sealed. Another novel feature is to be found in the corrector plate which is used to project the large picture from the optical image formed by a spherical mirror in front of the cathode ray tube. This corrector plate

is made by pouring a 10 per cent solution of gelatine in water into a chamber formed between a flat glass plate and a mould that has been optically worked to the required contour. On cooling, the gelatine solidifies and sticks to the glass plate, and the mould can be removed. The gelatine gel is then left to dry out, when it shrinks to one-tenth of its thickness, but retains exactly the contour given to it by the mould; any unavoidable defects in the mould, such as minute surface scratches, being reduced in proportion.

The whole projection television unit is made possible by the efficiency and cheapness of the corrector plate, combined with the use of a small cathode ray tube. The receiver is likely to prove suitable for providing entertainment and instruction in, for example, schools and clubs. In addition, it may be used like other television receivers on a closed circuit for relaying purposes inside a building, such as for displaying a surgical operation to students outside and away from the operating theatre.

ORGAN PIPE TONES

ALTHOUGH organ flue pipes are in common use and the practical organ builder can from long experience produce, purely empirically, a variety of musical tones, the tone-producing mechanism is at present obscure. So far, investigations have been made on the tones of pipes only in their finished condition, without examining effects of the adjustments made in 'voicing' the pipe; thus two articles which have recently become available, describing measurements of the steady-state acoustic spectra of pipes undergoing voicing operations, represent a more thorough attack on the problem and are very valuable.

The first is by K. T. Kuhn* and is entitled "Klangfarbe und Wirbelform einer Lippenpfeife in Abhängigkeit von der Bauweise". Three square wooden pipes were used, each speaking the same note, but with different cross-sectional areas; each pipe was of special construction, with lips and languid movable. By altering the position of one of these parts at a time, different voicing adjustments could be simulated, and in each case a set of graphs is given showing the effect on the first six harmonics of the particular adjustment for each of the three cross-sections. The effects are complex, since continued adjustment does not cause the harmonics to vary in a regular manner. It is surprising that no matter what is done to the pipe, the intensity of the fundamental varies comparatively little. The airflow at the mouth was also examined, stroboscopically, by the Schlieren method; qualitative agreement is shown between the mode of vibration of the air-stream and the harmonic content of the tone.

In the second article, by F. Ingerslev and W. Frobenius†, which is in English and is entitled "Some Measurements of the End-corrections and Acoustic Spectra of Cylindrical Open Flue Organ Pipes", the dependence of the physical length of the pipe on the mouth dimensions is derived theoretically; good agreement is shown with several observed values. For the voicing tests seventeen pipes were used, all speaking the same note but differing in diameter and mouth dimensions, and the acoustic spectra are compared and discussed. (It should be realized that the typical Danish pipe is of lighter and less forceful tone than its English counterpart.) Certain inharmonic fluctuating components were found, but were considerably reduced by 'nicking'. The semi-empirical formulæ given by J. G. Töpfer about a century ago, relating the dimensions of a pipe to its tone, were found to give fair agreement when tested. Measurements showed that, contrary to widespread belief, the edge-tone at the mouth is usually considerably higher in frequency than the fundamental of the pipe.

It is doubtless due to the practical experience of one of the authors of this second article as an organ-builder, that it is emphasized that a pipe must be correctly voiced and speaking its note properly for measurements on it to be of value; in practice it is seldom possible to adjust one variable alone over a wide range, so that it is doubtful if these conditions applied in the first article. The general conclusions of both papers confirm the estimates which have been made qualitatively on normal organ pipes. It is, however, clear, as the Danish authors stress, that much further investigation is required before organ tone can be thoroughly understood; the subtleties of tone which characterize an artistic voicer's work still await scientific analysis. D. M. A. MERCER

* Doctorate dissertation, Berlin (1940); FIAT microfilm *PBL* 73620, reel P 121, frames 6315–6334.

† *Trans. Danish Acad. Tech. Sci.*, No. 1, 7 (1947).

POPULATION OF BRITISH UNIVERSITIES DURING 1947-48

THE "Returns from Universities and University Colleges in receipt of Treasury Grants. Academic Year 1947–1948"*, recently issued by the University Grants Committee, would, in any event, have been examined with particular interest as the first annual return issued since that for the year 1938–39. Quite apart from the light the returns throw on the course of university expansion, observations by the Committee of Public Accounts in its third report for the session 1948–49 should increase the keenness with which the return is scrutinized. That Committee observes that the Universities Vote raises difficult issues, since rapidly increasing sums are involved, both for recurrent grants and for capital expenditure. The estimate for 1949–50 amounts to £17,564,500, as compared with £12,480,000 for 1948–49, apart from grants for the maintenance of students at the universities, also involving several millions of pounds but borne on other votes. Expenditure by universities, colleges, etc., in Great Britain out of the grants-in-aid is not accounted for in detail to the Comptroller and Auditor General, and the Committee of Public Accounts would like to see introduced more effective means of securing adequate Parliamentary control over this large expenditure of public money. The Committee was, however, impressed by the arguments advanced by the Treasury in favour of continuing the present system of administration without any enabling legislation. While the Committee does not wish to press for such legislation in the circumstances now prevailing, it suggests that the Treasury should consider whether, without impairing the independence of the universities, any further means could be adopted to inform Parliament more precisely how the grant-in aid proposed in the

* Returns from Universities and University Colleges in receipt of Treasury Grants. Academic Year 1947–1948. (University Grants Committee.) Pp. 28. (London: H.M. Stationery Office, 1949.) 1s. 6d. net.

estimate is to be spent and to assure Parliament that grants made to the universities are wisely used.

That suggestion should not be lost on the University Grants Committee or on the universities themselves. Whether the present returns can or cannot be expanded to supply the desired information, it is obvious that the maintenance of university autonomy under the new conditions will involve the supply through some channel or other of sufficient information for reasonable public discussions and criticism, inside and out of Parliament. While these returns include for the first time statistics for Hull University College and Leicester University College as well as for four constituent institutions of the University of London (Institute of Advanced Legal Studies, Warburg Institute, Wye College and the British Postgraduate Medical Federation), much desirable information is still lacking. In particular, the figures for income and expenditure at Oxford and Cambridge do not afford an accurate comparison with other universities, since they exclude all income and expenditure of the colleges, except the contributions of the colleges to the University, while a substantial part of the expenditure on teaching and administration is defrayed by the colleges.

Dealing first with finance, the income for the year amounted to £16,276,286, of which 7·6 per cent was represented by endowments, 2 per cent by donations and subscriptions, 4·8 per cent by grants from local authorities, 57·8 per cent by Parliamentary grants, and 21·4 per cent by fees. The total income for England was £13,056,875, of which £4,811,557 was for the University of London, £1,508,286 for Cambridge, £1,258,683 for Oxford and £5,478,349 for provincial universities and colleges. The figures for Oxford and Cambridge exclude college incomes, but subject to that qualification, it will be noted that Parliamentary grants represent 45 per cent and 48 per cent of the total income at Cambridge and Oxford, respectively, as against 23·4 per cent and 17·3 per cent from fees. The total income for Wales was £870,912 and for Scotland £2,348,499.

Of the total expenditure of £15,955,189, the sum of £526,115 represented allocations to reserves, and the remainder was distributed as follows: administration, 9·4 per cent; departmental maintenance, 66 per cent; maintenance of premises, 11·7 per cent; capital expenditure met from income, 2·6 per cent; other maintenance expenditure, 10·3 per cent, the largest item under the last head being the cost of the ordinary university examinations. Departmental maintenance includes the salaries of teaching and research staffs, superannuation and establishment costs of laboratories, lecture rooms, libraries, etc. The tables included in the return are sufficiently detailed to permit some interesting comparative calculations between universities. Library expenditure totals £458,516 for England, £19,234 for Wales and £73,126 for Scotland; this is further analysed in a separate table which shows that it averages 3·7 per cent of the total expenditure in England, 2·4 per cent in Wales and 3·4 per cent in Scotland.

Compared with the previous year, total income has risen by more than £3,232,000, chiefly through increases of some £2,531,000 in Parliamentary grants and more than £457,000 in fees, while expenditure has risen by some £3,004,000, of which £1,853,000 is represented by departmental maintenance (including £1,163,000 for salaries and superannuation of teaching staff, £572,000 for departmental and laboratory maintenance, and £107,000 for libraries), more than £309,000 by maintenance of premises and some £252,000 by administration. Compared with the academic year 1938–39, income has increased by £9,564,219, mainly through an increase of £7,011,640 in Parliamentary grants, which now represents 57·8 per cent of the total instead of 35·8 per cent. In the same period the endowment income, while increasing by £205,569, has shrunk from 15·4 per cent to 7·6 per cent, and fees from 7·4 per cent to 6·4 per cent, in spite of an actual increase of £1,481,507. On the other hand, while total expenditure has increased by £8,766,594, the distribution of expenditure is relatively unchanged. The full-time teaching staff in the same period increased from 3,994 to 6,536, mainly in the categories of lecturers and of assistant lecturers, which increased from 1,543 and 856 to 2,812 and 1,488, respectively. The number of professors rose from 889 to 1,079, and that of readers, assistant professors and independent lecturers from 369 to 537.

This increased staff has to cope with an increase of 28,505 students, the total of 78,507 full-time students being distributed as follows: arts, 44·9 per cent; pure science, 18·5 per cent; medicine and dentistry, 20·3 per cent; technology, 12·9 per cent; agriculture and forestry, 3·4 per cent, the corresponding figures for 1938–39 being 44·7, 15·3, 27·3, 10·6 and 2·1, respectively. Of these 78,507 full-time students, 5,805 were engaged in research or other advanced work, 64,015 were reading for a first degree and 8,687 for a diploma. Of these students, 58,301 were in English, 4,762 in Welsh and 15,444 in Scottish university institutions, the English total comprising 14,803 at Oxford and Cambridge, 16,611 at London and 26,887 at provincial universities and colleges. The proportion residing in colleges and hostels was 23·4 per cent (19·7 per cent for men, 34·4 per cent for women), while 37·1 per cent resided in lodgings and 39·5 per cent at home. Of overseas students from within the British Commonwealth, 3,188 were full-time and 1,403 part-time; a further 2,700 full-time and 1,089 part-time students came from foreign countries. Cambridge took 669 and Oxford 625 of these overseas students, but the only other institutions with more than 300 were University College, London (399), University of Edinburgh (396) and the London School of Economics (374), although the University of Manchester and the Imperial College of Science and Technology were only just short of that figure. A total of 23,507 students were admitted for the first time during the year, and of the grand total of 78,507, 75·2 per cent were men and 24·8 per cent women. Compared with the previous year, this total was an increase of 10,055, of which 1,313 were advanced students, the increase in England being 7,068 and in Scotland 2,330. The total entry for the year increased by 962, but the general outline of the distribution over subject groups of studies showed little change.

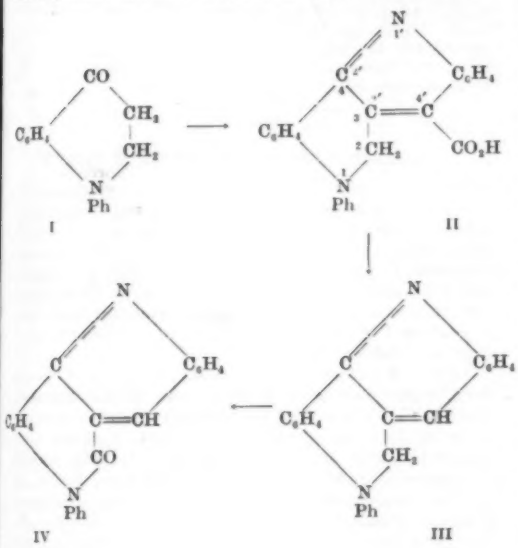
Of the 78,507 full-time students, 55,539 or 70·7 per cent were receiving assistance from Government departments, local authorities, universities or other bodies during the year, the percentage of assisted students for England as a whole being 72·1; for Wales and Scotland, the figures are 78·2 and 63·2, respectively. It is interesting to note that while the percentage of assisted students in the provincial universities is near to the average at 74·5, in the University of Oxford it is 80·4, in the University of Cambridge 77·7, and in the University of London 62·1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Structure and Colour in the 1 : 2-Dihydroquininolo(3′ : 2′ : 3 : 4)quinolines

THE preparation of 4-keto-1-phenyl-1 : 2 : 3 : 4-tetrahydroquinoline (I) has recently been described by Cookson and Mann[1], who showed that the phenylhydrazone of this ketone, when boiled with alcoholic hydrogen chloride, underwent indolization and dehydrogenation to give 1-phenyl-ψ-indolo(3′ : 2′ : 3 : 4)-quinoline. This yellow base gives colourless salts with acids, and further work has now confirmed the



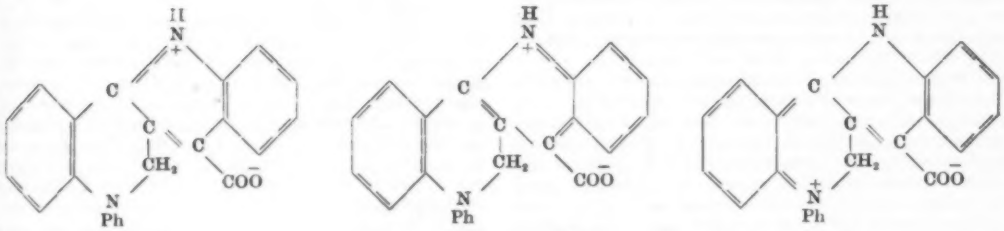
I II III IV

readily be isolated as bright yellow needles. If the acid (II) is heated in a vacuum, decarboxylation occurs, and 1-phenyl-1 : 2-dihydro-quininolo(3′ : 2′ : 3 : 4)-quinoline (III) distils. This base forms bright yellow crystals, but its hydrochloride forms deep garnet-red crystals.

Now the formal structure (II) does not account for the deep red colour of this acid. It is clear, however, from the above evidence that the free acid must exist as a zwitter-ion, which would be a resonance hybrid of the three canonical forms (II*A*), (II*B*) and (II*C*) and hence certainly coloured. The potassium salt, on the other hand, would necessarily have a structure of type (II), in which this resonance could not occur, and one would expect it to be much paler in colour. The decarboxylated base, however, has the structure shown in (III), and thus has also a yellow colour. Salt formation by proton addition gives a cation which again is a resonance hybrid of three canonical forms precisely similar to (II*A*), (II*B*) and (II*C*), with, of course, the —COO̅ group replaced by hydrogen ; and hence these salts in turn have a deep red colour similar to that of the free acid (II).

The base (III) shows one remarkable reaction. If the powdered crystals are heated at 120° in a stream of air, oxidation readily occurs with the formation of 1-phenyl-2-keto-1 : 2-dihydro-quininolo(3′ : 2′ : 3 : 4)-quinoline (IV). This compound, which forms cream-coloured crystals, can also be obtained by oxidizing the base (III) with a cold acetone solution of potassium permanganate, but not with hydrogen peroxide. The keto-base (IV) forms yellow salts, in marked distinction to the deep red salts of the base (III). This is not unexpected, because although the cation of these yellow salts might also be a resonance hybrid of three canonical forms similar in general type to (II*A*), (II*B*) and (II*C*), the contribution by the third form, having a positive charge on the phenyl-nitrogen atom, must now be very small, and the colour correspondingly less intense.

The structure of the keto-base (IV) has been indicated by its chemical properties, but placed



II*A* II*B* II*C*

structures suggested by the above workers for the base and its salts.

When the quinolone (I) is subjected to the Pfitzinger reaction, the products obtained show some very interesting features. If the quinolone (I) is boiled with isatin in sodium hydroxide solution, subsequent acidification gives 4′-carboxy-1-phenyl-1 : 2-dihydro-quininolo(3′ : 2′ : 3 : 4)quinoline (II) as deep red needles. An alcoholic solution of this compound has the properties of an indicator, for the addition of an excess of alkali causes the colour of the solution to change to bright yellow, while subsequent acidification restores the deep red colour. The potassium salt can beyond reasonable doubt by an infra-red spectroscopic investigation kindly undertaken by Dr. G. B. B. M. Sutherland.

The investigation of the compounds produced by the Fischer indolization and the Pfitzinger reaction when applied to a number of analogous cyclic keto-amines, for example, 4-keto-julolidine, has also been undertaken and will be described later.

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May 19.

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Anomalous Absorption and Photolysis of Iodobenzene

IODOBENZENE, as a vapour or in solution, is unstable to light, like the alkyl iodides, and lends itself to the same sort of photolytic study. Moreover, we have found that the presence of nitric oxide accelerates the decomposition, as is the case with methyl iodide[1]. The alkyl iodides show continuous absorption spectra in the near ultra-violet; but it would not be expected from preliminary considerations that iodobenzene would do so. Benzene and its simpler derivatives have been subjected to a great number of absorption measurements. The bands in the 2600 A. region found in benzene are considered to be due to a forbidden transition determined by symmetry considerations[2]. Substitution of a hydrogen atom by a fluorine, chlorine or bromine atom alters the symmetry, the band system becomes stronger and shifts towards the red end of the spectrum. The red shifts[3] in the case of fluoro-, chloro- and bromo-benzene for the $\nu(0—0)$ band are respectively -271, $-1{,}037$ and $-1{,}093$ cm.$^{-1}$. We might have expected the $\nu(0—0)$ band of the iodo-derivative to have displayed a red shift not very much larger than $-1{,}093$ cm.$^{-1}$; but substitution of the hydrogen by the iodine produces an anomalous result. There is still absorption in the 2600 A. region; but the discrete bands have disappeared, and only a continuous absorption is observed[4].

In order to confirm this, we carried out investigations on the absorption spectrum of pure iodobenzene vapour at different temperatures, using an Allen hydrogen arc[5] as a background of continuous radiation, and a grating spectrograph (Hilger 185) to give ample dispersion. No discrete bands or fine structure of lines were observed in the 2600 A. region, only continuous absorption, extending at high pressures from 2400 to 3000 A., with a broad maximum at 2600–2800 A. The absorption of iodobenzene in hexane solution shows a single band in the 2600 A. region, with a maximum at 2568 A. of molar extinction coefficient[6] 600. The same type of absorption is shown by the alkyl iodides. As iodobenzene liberates iodine under the influence of light in the same way as the alkyl iodides, we are led to assume that absorption of the light quantum takes place, not by the π-electrons, but in the C—I bond, or by one of the iodine electrons. Excitation to the unstable A-level takes place, leading to the splitting off of an iodine atom, analogous to the case of methyl iodide discussed by Mulliken[7]. If the photochemical behaviour of iodobenzene follows closely that of the alkyl iodides, we might expect the quantum yield to be lowered by the back reaction: $C_6H_5 + I = C_6H_5I$. In the presence of nitric oxide in sufficient concentration, however, the reaction $C_6H_5 + NO = C_6H_5.NO$ could take place, and the quantum yield for iodine formed (Φ_{I_2}) might be as high as unity.

The photolysis of iodobenzene dissolved in hexane in the presence of nitric oxide was carried out using previous techniques[1]. In this two-phase system it is not very easy to maintain constant conditions of saturation; but the results we have obtained are of an order of accuracy sufficient to support the general conclusion. In one such series of runs we obtained for Φ_{I_2}: 1·2, 1·12, 0·91, 1·1, 0·96, 1·04. A value of Φ_{I_2} considerably lower than this would indicate some kind of deactivation of excited molecules, which evidently do not exist. A higher value of Φ_{I_2} would indicate a chain reaction, which seems very improbable.

A molecule of another kind, such as iodoacetic acid, has continuous absorption in the vapour state, and a separate band, ~2600 A., analogous to the C—I absorption band of the alkyl iodides, some 400 A. to the long-wave side of the first acetic acid band.

We are investigating a whole series of carbon-iodine compounds in order to find out to what extent the C—I bond determines the spectroscopic character and photochemical behaviour of these complex molecules.

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T. IREDALE
A. H. KINGSBURY

Physico-chemical Laboratories,
University of Sydney. May 27.

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Constitution of 'Pure' Cellulose

THE word 'cellulose' possesses two connotations: in a technical sense it denotes products obtained by certain processes from vegetable material; in a chemical sense it is commonly used for a linear high-molecular polysaccharide composed solely of glucose residues linked by α 1·4 glucosidic bonds. It is, however, not yet established with certainty that this polysaccharide is really the main constituent of natural cellulose fibres.

Haworth[1] suggests the possibility of pairs of chains being joined together by cross-links of an unknown nature; he bases this hypothesis on methylation experiments, from the results of which it seems that adjacent chains are fixed relatively to each other. The pre-existence of cross-links between pairs is, however, not in agreement with the X-ray evidence, which shows that, in any one plane parallel to the fibre axis, all chains of a cellulose crystallite are linked together in the same way. On the other hand, the fixation of adjacent chains during the methylation as postulated by Haworth is well explained by the action of residual valencies, which hold together the chains during the permutoid reactions of cellulose. Furthermore, the solubility of cellulose, for example, in cuprammonium hydroxide, is incompatible with the net-like structure which would result from irregular cross-links. The conclusions of Pacsu[2] who postulates cross-links of a semi-acetal type are not sufficiently well grounded to be taken into consideration, especially since they were carried out on 'surgical cotton', a highly degraded cellulose. It is apparent that there is no valid evidence for the existence of primary valence cross-links, however disposed.

Raw cellulose contains carboxyl groups; several authors[3] concluded that a small but definite number of these groups may be present in each molecule of the original cellulose. We have, however, found that both cotton and α-cellulose from wood pulp, if re-precipitated from cuprammonium solution, washed, acidified and electrodialysed, are free from carboxyl groups. Samples of this highly swollen cellulose were shaken in a closed platinum dish with 0·6 N sodium chloride the pH of which had been adjusted to 6·2. After six days contact with the salt solution in order to establish the equilibrium, no change in pH was

observed. It follows that no groups of a dissociation constant higher than 10^{-7}, and therefore no carboxyl groups, exist in this cellulose. In contrast, groups with a dissociation constant of 10^{-6}, probably carboxyl groups, have been found in the so-called β-cellulose which is extracted from purified wood-pulp by 17 per cent caustic soda. We found approximately one group per 40 glucose residues. Details will be published elsewhere.[4]

Since the existence of the β 1-4 polyglucosan has thus been demonstrated, and since by far the greater part of cellulose fibres consists of it, it is proposed to term this polysaccharide 'pure cellulose'.

This chemical definition is analogous to the definition proposed for amylose, which is defined as the α 1-4 polyglucosan isomeric with 'pure cellulose'. Quite apart from the possible existence of branched or cross-linked polyglucosans, questions as to whether amylose or pure cellulose is slightly branched or cross-linked cannot arise if these simple definitions are accepted.

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M. STUDER
A. J. A. VAN DER WYK

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Inorganic Chemistry,
University of Geneva. June 11.

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Variation in Density and Colour of Cerium Oxide

R. C. VICKERY has stated[1] that evidence for more than one crystal structure has been obtained when preparing cerium oxide by igniting various salts of cerium. He classified some preparations he had made into four groups on the basis of density measurements and colour estimations. Referring to work by Wyrouboff and Verneuil, who have suggested that three polymorphic varieties of this oxide might exist, Vickery claimed that a fourth may be indicated as a result of his work. He prepared various salts, starting with the same source of cerium, and fired these for 1 hour at 1,200° C. to secure complete conversion to the oxide. If by this process oxides of different crystal structure are really produced, important and far-reaching effects on solid reactions generally can be envisaged.

In order to check the structures, six of the preparations on which density and colour determinations were made were kindly supplied by Vickery and subjected to X-ray diffraction examination.

No evidence for a polymorphic form of cerium oxide was obtained. The oxide (CeO_2) had, as usual, the calcium fluoride structure, the side of the unit cell remaining constant at $5{\cdot}400 \pm 0{\cdot}002$ kX. in each of samples 1, 2, 4, 5 and 7, whereas 3 gave a value of $5{\cdot}408 \pm 0{\cdot}002$ kX. That 1 and 3 have the same density and colour indicates that whatever caused the small change in the dimensions of the unit cell cannot affect the colour, and will certainly not affect the density to the extent indicated by the results given. The answer to the problem seems more likely to be found in the degree of crystallization and crystal size.

If classified on the basis of the breadth of the high-angle reflexions, a factor which may be related to the degree of crystallization, the specimens fall into two groups of similar colour and density. Samples 1 and 3 had approximately the same breadth of lines, 4 and 7 had also the same breadth though less diffuse than 1 and 3. As 5 contains an extra component, not CeO_2, the colour and density will be affected adversely, and it is not surprising, therefore, if it does not fit in with this scheme.

The effect of variations in perfection of the structure on the colour of pigments is well known, and it appears that this is another example of it. The variations in density, as measured pyknometrically, can be explained on the basis of failure to remove entrapped air, a troublesome and often incomplete operation. The packing of the finer grains in 1 and 3 will quite reasonably lead to a higher apparent density of product.

I wish to thank Mr. J. A. M. van Moll and the directors of Philips Electrical, Ltd., for permission to publish this note.

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Mitcham Junction,
Surrey. June 2.

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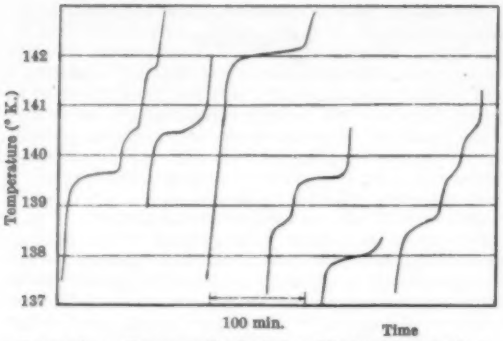
Polymorphism in Tin Tetra-ethyl and Related Compounds

IN the course of a calorimetric investigation of the thermodynamic properties at low temperatures of the tetra-alkyl compounds of Group 4 elements, we have found that tin tetra-ethyl has an unusually large number of melting points. All these lie in the range 137–147° K. When this substance is cooled, it almost always supercools considerably before crystallizing, and it can, in fact, be kept as a glass at liquid air temperatures for at least two or three days. On warming the crystalline solid, the temperature – time curve may show the normal behaviour of a single arrest while melting is taking place, or it may display two, three or even more arrests. The temperatures at which these occur are reproducible, and in some twenty experiments (series I), in which the solid was melted in a low-temperature calorimeter[1], the existence of at least five such temperatures was established. Six of the curves obtained, which between them indicate five melting points, are shown. In some of the calorimetric experiments the sample was deliberately heated continuously in order to minimize the chance of any recrystallization occurring after melting had started. The arrests in these runs are inclined and not horizontal.

Further experiments (series II) were then carried out on a different sample in a glass apparatus in which the temperatures were measured with an ethylene vapour-pressure thermometer. Phenomena of the same kind were observed, and it was now possible to see that the arrests in the temperature – time curves did, in fact, correspond to melting of the crystalline solid. The highest melting point found in series I was encountered several times in series II; but in only two of the twelve experiments of series II were any of the lower melting points in series I reproduced. Usually in series II the arrests occurred at temperatures which were higher than any observed in series I. Finally, a third set of experiments (series



Temperature – time curves for the fusion of tin tetra-ethyl (series I)

III) was performed in a melting-point apparatus similar to that in use at the U.S. Bureau of Standards[3], in which temperatures were measured with a three-junction copper-constantan thermocouple. In series III some of the melting points observed corresponded to the lower values of series I and some to the higher values of series II.

From these experiments we conclude that when crystalline tin tetra-ethyl is heated, arrests in the temperature – time curve at which melting takes place may occur at no less than ten temperatures, and possibly more. The values for the ten melting points (in ° K.) which we regard as definitely established are as follow: 137·45 (2 III); 138·1 (2 I, 1 III); 138·45 (9 III); 138·75 (5 I, 1 II, 1 III); 139·8 (6 I, 2 II); 140·6 (4 I); 142·05 (7 I, 5 II, 5 III); 143·05 (4 II); 145·75 (6 II, 1 III); 147·05 (5 II).

The figures in brackets after each temperature give the number of times this melting point was observed in a given series. Although these melting points are very close together, we wish to emphasize that melting does not appear to take place at *any* temperature between 137° and 147° K., but only at certain definite temperatures.

Similar experiments now in progress on lead tetra-ethyl have already shown that this substance also has several melting points. Preliminary investigations on the germanium compound, however, have so far given no indication that it has more than one (about 40° above the melting point of tin tetra-ethyl), and in our calorimetric studies of carbon tetra-ethyl, and tin and lead tetra-methyls, there was likewise no evidence that these compounds can crystallize in more than one form.

These comparisons suggest that the crystallization of tin and lead tetra-ethyls in a large number of different, yet very similar, solid forms is intimately connected with the presence of the ethyl groups, and at the same time depends on factors which are very sensitive to the intramolecular distances. There is reason for believing that in the tetra-methyl compounds the barrier restricting free rotation of the methyl groups rapidly diminishes in magnitude as the size of the central atom increases, until in the tin and lead compounds it is so small that the methyl groups probably rotate freely[3]. A consideration of the dimensions of the tetra-ethyl compounds of tin and lead, however, shows that in these molecules interference to completely free rotation of the ethyl groups about the Sn—C and Pb—C axes will arise from the partial overlapping of the paths which the peripheral methyl groups would follow. Furthermore, the molecular volumes of these substances are such that, whatever their crystal structure, there must be considerable interlocking of adjacent molecules in the solid state. We therefore consider it possible that the various crystalline forms differ in that the molecules in them have adopted different configurations with different dispositions of the methyl groups, so that the interaction between the peripheral methyl groups of one molecule and those of adjacent molecules, and between these groups in one and the same molecule, differs slightly from one form to another. In the much more compact molecule of, say, carbon tetra-ethyl, the large potential barrier restricting free rotation about the bonds of the central carbon atom, coupled with the now much greater overlapping of the regions in which the methyl groups must move, may combine to make one configuration of the molecule in the lattice so much more stable that only one form exists.

A full account of this work will be published elsewhere.

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(n,γ) Recoil Effects in Potassium Chromate and Dichromate

Muxart *et al.*[1] have recorded their failure to obtain an appreciable Szilard–Chalmers enrichment of active chromium from potassium dichromate, despite the apparent absence of exchange between $Cr(H_2O)_6^{3+}$ and $Cr_2O_7^{2-}$ ions in aqueous solution. (It is not apparent from their paper whether they were working with chromium-51 or with chromium-55.) The result was unexpected, the more so when the results of Menker and Garner[2] were published.

We have irradiated crystals of potassium dichromate ('Analar' grade), sealed in a silica ampoule in air at atmospheric pressure, with thermal neutrons in the large pile at the Atomic Energy Research Establishment, Harwell. Aqueous solutions of the dichromate of 0·008 *M* concentration were used in the subsequent chemical manipulations. To aliquots of the various solutions were added measured volumes of the same solution of chrome alum as carrier; from the mixtures chromic hydroxide was precipitated, the activity of the precipitate was determined and the percentage of chromium-51 present in the solutions as trivalent ions calculated. Precipitates were uniformly deposited on hard filter papers held in polystyrene holders and measured directly in the holder. The usual corrections to the observed counting-rate were made, self-absorption losses being allowed for by means of an empirical correction curve prepared under identical counting conditions.

In terms of the 'retention' (R), defined as the percentage of the total chromium activity retained in the hexavalent form, typical results are: at *p*H 14, $R = 87$, 88·2 per cent; at *p*H 5, $R = 89·5$, 89·6 per cent; at *p*H 0·7, $R = 86·7$, 86·8 per cent. The probable error of the measurements is $\pm$ 2 per cent of the yield (100—R). The results indicate that a

small but definite Szilard–Chalmers separation occurs, the yield, 12 per cent, depending little, if at all, on the *p*H of the solution in which the irradiated dichromate is dissolved.

The separation of the chromium-51 is not influenced by the quantity of the carrier added or the time (up to four hours) between addition of the carrier and its separation. Identical results are obtained if chromic chloride is used as carrier or if separation is made by precipitation of chromic phosphate, or if the retention is measured directly by precipitation of silver chromate.

In the case of potassium chromate, the procedure was very much the same, but considerable variation of the retention with the *p*H of the solution in which the chromate was dissolved was found. Thus the retention *v.* *p*H curve runs smoothly from $R = 76$ per cent at *p*H 10·6 to a minimum of $R = 55$ per cent at *p*H 2·0 and rises to $R = 70{\cdot}6$ per cent at *p*H 0·0. This variation is similar in character to that observed by Libby[3] for solutions of irradiated potassium permanganate crystals, but is not necessarily explained by an analogous mechanism.

The application of this effect to the production of sources of chromium-51 of high specific activity is shown by an experiment in which a sample of chromic hydroxide (~ 2 mgm.) of specific activity 3 C./gm. was prepared.

The effect of heat on the metastable ions present in the irradiated chromate was investigated by heating a sample to 480° C. for some time, then dissolving in water and measuring the retention. The results are shown in the table.

Time heated (hr.)	*p*H of solution	*R* (per cent)
0	2·0	55
1	0·7	95·3
		95·2
19·5	2·24	93
	2·1	92
	9·6	94
24	0·7	95·8
		95·7

The existence of any *p*H effect on the retention in this case will be revealed by experiments in progress using larger activities. It is interesting that, at this temperature, the change appears to be very fast, and that a definite fraction of the active atoms remains in a form which gives chromic ions on dissolution in water.

If the irradiated potassium chromate is dissolved in an excess of potassium dichromate solution, the retention observed is equal to that found on the dissolution of irradiated potassium dichromate in solutions of the same *p*H. This observation suggests that a bimolecular mode of reaction of the metastable ions occurs.

More precise determinations of the magnitude of these effects are in progress, and will be reported elsewhere together with a theoretical interpretation of the results.

One of us (J. H. G.) wishes to acknowledge the grant of a Senior Research Studentship by the Australian Commonwealth Scientific and Industrial Research Organization, which is responsible for his presence in England.

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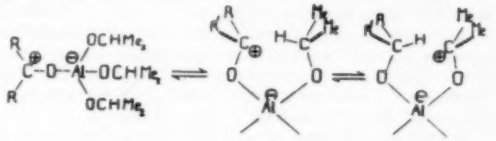
Mechanism of the Meerwein–Ponndorf Reduction

The mechanism of this reaction is not definitely known, because of the absence of kinetic data; but the following scheme appears to be in harmony with known facts:



(*A*) (*B*) (*C*)

The carbonyl compound in its activated state becomes co-ordinated with the aluminium in aluminium *iso*propoxide, giving the co-ordination complex (*A*), which may then assume a configuration (*B*), facilitating the direct transfer, through a cyclic transition state, of a hydrogen atom from an *iso*propoxide radical to the carbonyl carbon, leading to the structure (*C*), which then dissociates into acetone and an aluminium derivative of the carbinol formed in the reduction.

Mechanisms involving co-ordination complexes of type (*A*) have been proposed by Meerwein[1], Hammett[2] and Woodward[3], and, taking into account the probable 'intramolecular' transfer of hydrogen through a cyclic transition state, they seem to account best for several features of the reaction. The intramolecular transfer is implied in Woodward's formulation. Aluminium *iso*propoxide is shown as the true reductant, and not merely a catalyst, because reductions may be carried out in the absence of free *iso*propyl alcohol, using aluminium *iso*propoxide either alone in the fused state (unpublished observation) or dissolved in hydrocarbons.

Woodward[3] and Doering[4] have shown that for the interconversions between quinine epimers and the quininones, aluminium alkoxides are advantageously replaced by alkali metal alkoxides, and Woodward regards this reaction of quininone as a special case of a general base-catalysed hydrogen transfer. It is evident, however, that in the normal Meerwein–Ponndorf reduction, the aluminium alkoxide functions as a reductant *per se*, and not by virtue of any alkoxide ions which it may provide, because nitro groups are unaffected, halogen atoms are only removed when highly reactive, and there is retention of optical activity during the reduction of ketones such as piperitone[5], which readily undergo racemization in the presence of alkoxide ion. The marked superiority of aluminium alkoxides over other alkoxides points to some unique property of the aluminium atom, such as covalent radius or bond angles.

No direct evidence is available for the existence of a cyclic transition state during the reduction, but such a six-membered structure is stereochemically feasible, and considerable reduction in activation energy should result from resonance in the transition state. The non-reduction of the carbon-to-carbon double bond in α : β-unsaturated carbonyl compounds may be due to the need for an eight-membered cyclic transition state to include reaction at the double bond, and this is unlikely from stereochemical considerations.

We have investigated the reduction by aluminium alkoxides of some substituted *cyclo*hexanones, which may give rise to *cis*- and *trans*-substituted *cyclo*hexanols, and we find that, as the apparent steric

hindrance is increased, either in the ketone or the reducing alcohol, there is an increase in the proportion of *cis* isomer in the mixture of alcohols produced (for example, 2-methylcyclohexanone gives 50 per cent *cis*, whereas menthone gives 70 per cent *cis*). Construction of models of the postulated transition state shows that this trend should be observed in such reductions.

Any mechanism for the Meerwein–Ponndorf reduction should account for its specific nature and the excellent yields obtainable, and free-radical mechanisms such as that proposed by Hodgson[6] are less satisfactory from this point of view.

It is probable that if experimental conditions are chosen to suppress competing side-reactions (Tischtschenko reaction, aldol condensation), and if the product does not undergo further reaction (dehydration or rearrangement), the yields in this reaction will be practically quantitative. One way of greatly improving the yields, particularly from aldehydes and highly reactive ketones, is to add the carbonyl compound slowly during the reaction, so that its concentration in the mixture is always very low. An example of the value of this modification is the reduction of benzalacetone, which gives styryl methyl carbinol in 95 per cent yield.

We wish to acknowledge financial assistance from the Commonwealth Research Fund.

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State of Manganese in Manganese Oxides

Chemical estimation of trivalent manganese has been possible using a stable complex ion formed with acetylacetone. This complex is formed from solutions of red manganic sulphate and also when γ-Mn_2O_3 is dissolved in concentrated hydrochloric acid in the presence of acetylacetone.

When manganese dioxide is dissolved in hydrochloric acid in the presence of acetylacetone, only one equivalent of chlorine is liberated in place of the normal value of two equivalents. It is thought that in the presence of excess acetylacetone, the manganese tetrachloride ($MnCl_4$) reacts to form the stable trivalent complex ion, the chlorine liberated chlorinating the acetylacetone rapidly.

In the presence of 0·5 normal potassium iodide and normal hydrochloric acid, the chlorinated acetylacetone reacts quantitatively to liberate one equivalent of iodine. Thus it is possible, using acetylacetone, to estimate manganese tetrachloride in the presence of manganese trichloride, and the sum of the concentrations of the two chlorides can be estimated separately in the absence of acetylacetone.

Using acetylacetone, the following oxides have been analysed and have reacted as the ion mixtures tabulated below.

α-MnO_2	Mn^{++++}
Mn_3O_4 (hausmannite)	$Mn^{++++} + 2Mn^{++}$
$ZnMn_2O_4$ (franklinite)	$Mn^{++++} + Mn^{++}$
α-Mn_2O_3 (bixbyite)	$Mn^{++++} + Mn^{++}$
γ-Mn_2O_3	$2Mn^{+++}$

Forms of manganese dioxide after solution in hydrochloric acid react chiefly as tetravalent ions. However, oxygen-deficient types as described by Cole, Wadsley and Walkley[1] give rise to a certain quantity of trivalent ions. The reaction of Mn_3O_4 is in agreement with the structure proposed by Verwey and deBoer[2] of $Mn^{++++}2Mn^{++}O_4$. It has a deformed spinel structure with sixteen cations in octahedral positions and eight in tetrahedral positions. From radius–ratio considerations it appears that the cation of manganese most suitable to occupy the tetrahedral positions is the tetravalent ion with a radius of about 0·52 A. Franklinite, which also has a spinel structure, reacts as would be expected from the analogy with Mn_3O_4.

The γ-form of manganic oxide (Mn_2O_3) on solution in hydrochloric acid reacts entirely as trivalent ions. This is in agreement with the proposal of Verwey and deBoer[2]. The reaction of α-Mn_2O_3 is anomalous. This oxide has the *C*-type oxide structure typical of certain rare earth oxides. From present evidence it is difficult to decide if all the cations are strictly equivalent. However, all the atoms are in six co-ordination, and it seems unlikely that the tetravalent manganese ion could occupy these positions, due to its small size. Zachariasen[3] considers all these oxides to contain trivalent ions.

Reaction between Mn^{++} and Mn^{++++} to produce Mn^{+++} as described by Cowley and Walkley[4] does not seem to occur in the presence of acetylacetone, probably due to the removal of a chlorine atom from the manganese tetrachloride and its addition to the acetylacetone.

A complete study of the reaction of all manganese oxides, the kinetics of the reaction and the nature of the complex ions will be published elsewhere.

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Effect of Adrenal Cortical Steroids upon the Formation of Carbohydrate by Rat Liver Slices

Seckel[1] showed that addition of eschatine (adrenal cortical extract) to rat liver slices incubated aerobically in phosphate–Ringer solution caused inhibition of glycogenolysis. This was confirmed by Chiu and Needham[2], who found, further, that this inhibition is absent if incubation takes place in an atmosphere of nitrogen. They therefore suggested that the effect of the hormone is on glycogen synthesis, the degree of glycogenolysis observed being the resultant of simultaneous breakdown and synthesis. Deane *et al.*[3] have, indeed, shown histologically that, under similar conditions to ours, glycogen disappearance may occur in one part of a liver slice while formation is occurring in another part. When the effect of the hormone was tested under conditions favourable to synthesis of glycogen, that is, in the presence of substrates such as pyruvate, lactate, glutamate, an increased synthesis was observed over that in the control without hormone.

These experiments have been extended to include the effect of three pure steroids, desoxycorticosterone (as acetate and succinate), 11-dehydro-corticosterone and 17-hydroxy-11-dehydro-corticosterone. Each brought about decreased glycogenolysis in the absence of substrate and increased formation of glycogen in the presence of substrate. The effect of desoxycorticosterone differed little from that of the two other steroids.

Livers of well-fed animals were always used for the experiments without added substrate, while livers of animals fasted 24 hr. were used when substrate was added.

Table 1. Glycogen content expressed as mgm. per 100 mgm. tissue.

Without added substrate. Medium: Seckel's phosphate–Ringer, *p*H 7·4. Gas phase: air. Time of incubation at 37°: 20 min. Concentration of steroid: 25 γ per ml.

Initial	Final			
	Without steroid	+ Desoxycorticosterone succinate	+ 17 hydroxy-11-dehydro-corticosterone	+ 11-dehydro-corticosterone
2·85	0·85	1·59	1·31	1·27

With added substrate. Medium: Krebs's bicarbonate–Ringer, *p*H 7·4. Gas phase: 95 per cent oxygen, 5 per cent carbon dioxide. Time of incubation at 37°: 60 min. Concentration of steroid: 20 γ per ml. Substrate, 0·4 per cent pyruvate

Initial	Final	
	Without steroid	+ desoxycorticosterone acetate
0·463	0·363	1·042

Investigation was also made of the effect of eschatine and of the pure steroids on total carbohydrate. Various methods were used for 'total carbohydrate' estimation: (*a*) acid hydrolysis of slices plus medium, followed by precipitation with zinc sulphate and baryta, the reducing substances then being estimated by Nelson's method; (*b*) the same two stages followed by estimation of glucose by glucose oxidase; (*c*) estimation of glycogen in the slices and glucose in the medium without acid hydrolysis. This last procedure probably does not show the whole of the carbohydrate, but gives useful information.

By all these methods the action of these substances in increasing total carbohydrate content in the liver slices incubated with or without substrate was demonstrated, and the effect was often much more striking than on glycogen content alone. Other workers have noted that total carbohydrate in liver slices may increase slightly on aerobic incubation even without added substrate. In some of our experiments without added substrate where the pure steroids were present, very large increases in total carbohydrate were found. Desoxycorticosterone was fully as effective as the other two steroids.

Table 2. Total carbohydrate expressed as mgm. glucose per 100 mgm. tissue.

Without added substrate. Medium: Seckel's phosphate–Ringer, *p*H 7·4. Gas phase: air. Time of incubation at 37°: 20 min. Concentration of steroid: 12·5 γ per ml.

Initial	Final			
	Without steroid	+ Desoxy-corticosterone succinate	+ 17-hydroxy-11-dehydro-corticosterone	+ 11-dehydro-corticosterone
2·85	2·95	4·98	4·06	4·62

With added substrate. Medium: phosphate–Ringer, *p*H 7·4. Gas phase: 100 per cent oxygen. Concentration of steroid: 12·5 γ per ml. Substrate: 0·4 per cent pyruvate. Time of incubation at 37°: expt. *a*, 120 min.; expt. *b*, 60 min.

Initial		Final			
		No steroid	+ Desoxy-corticosterone acetate	+ 17-hydroxy-11-dehydro-corticosterone	+ 11-dehydro-corticosterone
(*a*)	0·319	0·487	0·653		0·661
(*b*)	0·334	0·382		0·496	

These results may be compared with those recorded by other workers for the action *in vitro* of desoxycorticosterone and corticosterone on glycogen content of diaphragm incubated in glucose-containing medium. Verzar and his collaborators[4,5] and Bartlett *et al.*[6] found that desoxycorticosterone decreased glycogen formation and glucose uptake; corticosterone had a similar though smaller effect. Riesser[7], however, concluded from his experiments that desoxycorticosterone and cortin had no effect.

The three steroids which we tested have no significant effect on oxygen uptake of the liver slices; this was found in experiments in which a marked increase in total carbohydrate content resulted from the presence of the steroid. Bartlett *et al.* found with diaphragm that the decrease in glycogen synthesis resulting from the presence of desoxycorticosterone was unaccompanied by any change in oxygen uptake.

Since *in vivo* adrenal cortical steroids seem to affect carbohydrate synthesis from protein, it may be that the increased content in carbohydrate found in liver slices in their presence arises from the same origin. This may be the case even when substrate is added. We have not investigated the effect of the hormones on urea formation, since the initial urea content of liver slices is extremely variable, however carefully the sampling is done; we did not wish, at this stage of the work, to use washed slices because of possible effects upon the power of carbohydrate synthesis. We found, however, that even in unwashed slices the initial content of non-protein nitrogen is very constant in slices from different parts of the same lobe. The presence of hormone always led to a slight but definite increase in the non-protein nitrogen fraction.

Table 3. Medium: phosphate–Ringer, *p*H 7·4. Gas phase: air. Concentration of steroid: 25 γ per ml.

		Mgm. non-protein N per 100 mgm. tissue. After 60 min. at 37°	Total carbohydrate as mgm. glucose per 100 mgm. tissue. After 60 min. at 37°
(*a*)	No steroid	0·161	1·47
	+ Desoxycorticosterone succinate	0·184	2·12
(*b*)	No steroid	0·150	1·06
	+ Desoxycorticosterone succinate	0·169	1·72

The total amount of non-protein nitrogen present (which must include urea) seems small even in the samples with hormone, if one supposes that the extra carbohydrate is formed at the expense of protein, intermediate breakdown products or amino-acids. Possibly with protein, as with glycogen, breakdown and synthesis are both going on in the slice, in different locations. The connexion between nitrogen metabolism and carbohydrate synthesis is being further investigated. This work will be reported in detail elsewhere.

We are indebted to Messrs. Parke, Davis and Co. for gifts of eschatine free from preservative; and to the Organon Laboratories, Ltd., Ciba, Ltd., and Dr. Reichstein for gifts of pure steroids.

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Action of Cardiac Glycosides on the Polymerization of Actin

ACCORDING to Szent-Györgyi[1], muscular contraction involves the following reaction: at certain salt concentrations, actomyosin, formed from myosin and polymerized actin, loses water and contracts by the action of adenosinetriphosphate. Actin may be present in two forms: in a globular and a fibrous form. In the presence of salts, globular actin is transformed into the fibrous form, that is, polymerization takes place. Only at this stage is actin able to form with myosin the highly viscous actomyosin. Straub *et al.*[2] showed that adrenaline increases, chinine and veratrine diminish, the speed of polymerization.

We thought that heart glycosides, which have an elective action on heart muscle, might influence the polymerization of actin prepared from cardiac muscle, although they have no effect, or only at very high doses, on actin obtained from skeletal muscle.

Actin was prepared from heart muscle of the dog by a slight modification of the method of Straub *et al.*[2]. We have observed that the protein fractions can be extracted faster from the muscles of animals as they go down in phylogenetical order[4]. Further, protein fractions can be extracted faster from animal muscles as they become less and less differentiated. As a result, we decreased the time and temperature of extraction and also that of the volume of extraction fluids. The actin solution obtained from the acetone dry powder has a dry material content of 3–4 mgm. Viscosities were measured in Ostwald viscosimeters.

Our investigations show that the polymerization of actin prepared from heart muscle is accelerated even by 0·2–0·3 γ/ml. of crystalline strophantine-*G* and by the same amount of digitoxin in a salt concentration of 0·001 *M* magnesium chloride and 0·1 *M* potassium chloride, when the solution of actin has a dry content of 2–3 mgm./ml. Maximal effect is obtained by 2–4 γ/ml. strophantine-*G* and digitoxin. On the other hand, even 100 γ/ml. strophantine had no effect on the polymerization of actin prepared from skeletal muscle.

These observations support Straub's view that the polymerization of actin is an integral part in the mechanism of muscular contraction. Further, these findings suggest that in the mechanism of action of cardiac glycosides on heart muscle, their effect on the polymerization of actin may play a part.

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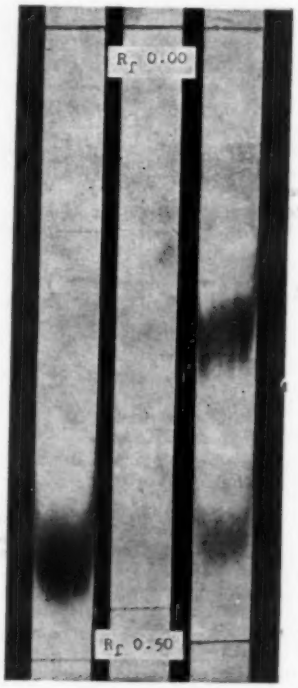
Keto-Acid Content of Human Blood and Urine

THE common procedure used to detect the keto-acid content in a biological material is usually confined to the isolation of the dinitrophenylhydrazone derivatives from a deproteinized sample, followed by the photometric evaluation of the red colour which they develop with addition of alkali. The results are expressed as milligrams of pyruvic acid, which is believed to be the main biological constituent of this class of compounds. Actually, the method is regarded as a method for pyruvic acid determination[1,2]. This method is, of course, not specific for pyruvic acid, since other keto-acids may be present in the sample giving the same reaction as pyruvic acid. It is not accurate, either, for the keto-acids as a class of compounds, since different phenylhydrazones with alkali show different colour intensities for each one of them[3]. Furthermore, some carbonyl compounds are partially extracted, so increasing the inaccuracy. In order to improve the specificity towards pyruvic acid, the procedure has been modified[4–6]; but it is not yet satisfactory.



Centre: Filter-paper chromatography of keto-acids in human blood. Left: The same with pyruvic acid added. Right: The same with α-ketoglutaric acid added

Recently, we reported on the successful separation of some dinitrophenylhydrazone of keto-acids of biological interest by making use of filter paper chromatography[7,8]. This fact enabled us to analyse the mixture of keto-acids, extracted by the usual method, and to carry out their quantitative determination. The purpose of the present communication is to describe the procedure adopted, and report the first results obtained by its application to normal blood and urine.

A volume of 10 ml. of blood, collected according to Long[9], is deproteinized by 30 ml. 5 per cent metaphosphoric acid. To a 20-ml. aliquot of the filtrate is added 2 ml. of 0·2 per cent 2,4-dinitrophenylhydrazine in 2 *N* hydrochloric acid, keeping the mixture for 20 min. at 38°. The hydrazones are extracted as usual[2] four times with 4 ml. ethyl acetate, centrifuging

if necessary. The ethyl acetate is then extracted with 8 ml. of 10 per cent sodium carbonate solution in portions. The combined carbonate extracts, freed from dinitrophenylhydrazine by a further extraction with 2 ml. ethyl acetate, are acidified in the ice-cold condition, using concentrated hydrochloric acid. The hydrazones are transferred again into 8 ml. ethyl acetate in portions, and the solvent evaporated in vacuum with slight warming. The completely dry residue is dissolved in 0·2 ml. ethanol and neutralized with 0·3 ml. phosphate buffer $M/10$, pH 7·2. If the solution still reacts acid, the required amount of sodium hydroxide solution may be added from a burette. 0·1–0·2 ml. of this material is disposed on a filter-paper strip and chromatographed as usual[7], using butanol–ethanol 20 per cent mixture as solvent. The same procedure can be adopted for urine and organ extracts, though the final dilution may vary as regards the amount of the extracted material. The portions of filter paper upon which the spots are located, previously identified by their R_f values, are cut into small fragments and extracted separately with 2 ml. of 10 per cent carbonate solution in portions. To each filtered extract, 1 ml. of 3 N sodium hydroxide solution is added, and the red colour is then compared, by using a microcuvette and a No. 510 filter, with a standard curve obtained with pure samples of the dinitrophenylhydrazone in question.

By this procedure we found in blood and urine two constant spots identified as α-ketoglutaric acid and pyruvic acid (see illustration), while a third spot with R_f 0·53 and a fourth one located behind the solvent front appeared occasionally. The identity of the third spot is under investigation; the fourth spot, owing to the high solubility in butanol–ethanol, is presumed to be due to a carbonyl compound rather than to a keto-acid. The average values for α-ketoglutaric acid and pyruvic acid in five samples of normal human blood and urine are:

	α-Ketoglutaric acid	Pyruvic acid
Blood	0·21	0·28 (mgm. per cent)
Urine	20·50	3·24 (mgm. in 24 hr.)

It is noteworthy that the value for pyruvic acid found in the same blood samples by the usual procedure[8] averaged 0·88 mgm. per cent. Since our method has an accuracy for pyruvic acid of the order of 91 per cent, it follows that about two-thirds of that amount cannot be due to pyruvic acid itself, being α-ketoglutaric acid, an unidentified keto-acid, a carbonyl compound and, probably also, other keto-acids spread over the strip but too weak to give a visible spot on the paper.

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Nucleic Acid Synthesis in the Liver Cell after Methylthiouracil

In earlier experiments[1] it was demonstrated that the disturbance in thyroid secretion caused by methylthiouracil in rats is connected with a decrease in the content of ribose nucleic acid and desoxyribose nucleic acid in the glandular cells. These findings were discussed from the point of view of the association between hormonal secretion and the metabolism of nucleotides, which is suggested by several cytological signs.

The compound 4-methyl-2-thiouracil responsible for these changes is, however, closely related to one of the structural units, uracil or thymine, of both nucleic acids. After its administration, and before it is decomposed, it accumulates in the liver, which is known especially for its extensive metabolism of ribose nucleic acid. In the experiments to be described, the question of whether the treatment with methylthiouracil is followed by any changes in the biosynthesis of both nucleotides in liver cells was studied.

The level of ribose nucleic acid and desoxyribose nucleic acid in the liver was assessed by the method of v. Euler and Hahn[2], consisting of a cold extraction of the minced tissue twice with 10 per cent sodium chloride and then twice with 0·2 N sodium hydroxide. The nucleic acids present in the combined extracts were precipitated as lanthanum salts, and after decomposing the lanthanum nucleate precipitate with sodium carbonate, the ribose nucleic acid was determined photometrically by the phloroglucinol test (Euler, *l.c.*), and the desoxyribonucleic acid by Dische's method[3]. (Euler *et al.*[4] found that Dische's reaction is liable to errors resulting from the presence of proteins; but it seems to be the best method available at present.) The analytical findings were compared with the microscopic examination of liver sections. Young male albino rats of the laboratory stock, weighing 140–160 gm., were used for the experiments. The compound 4-methyl-2-thiouracil was given by a gastric tube in the dose of 0·33 mM a day for each rat.

The results summarized in the table show that, whereas the incorporation of methylthiouracil does not affect the desoxyribose nucleic acid content of the liver cells, it produces an increase in the ribose nucleic acid which appears to be significant. These findings were confirmed cytologically by staining with toluidine blue and by Unna–Pappenheim's method. Both methods demonstrated an increase in the amount of chromophile granules in the cytoplasm of the liver cells after seven or twelve days administration of methylthiouracil. The identity of these granules with ribose nucleic acid was demonstrated with the aid of a crystalline ribonuclease.

Sadhu and Brody[5], and recently Studer[6], have described a reduction in the thiouracil hyperplasia of the thyroid after large doses of vitamin A. With regard to the importance of axerophtol in the cellular biosynthesis of purines and nucleotides, we have further studied the level of both nucleotides in the liver after the simultaneous administration of methylthiouracil and vitamin A.

According to analyses, the amount of ribose nucleic acid and desoxyribose nucleic acid in the liver was the same as when methylthiouracil was given alone. Cytological examination confirmed this result, showing the same increase in chromophile granules as after the administration of the single drug. Vitamin A, therefore, does not exert a protective influence on

Amount of nucleic acids in the liver

No. of rats	Agent	Duration of treatment	Ribose nucleic acid				Desoxyribose nucleic acid		
			Mean ($\bar{X}$)	S†	S_M††	P†††	Mean ($\bar{X}$)	S	S_M
		days	gm. per 100 gm.				gm. per 100 gm.		
17	None	—	0·881	0·18	0·04	—	0·272	0·05	0·01
10	4-Methyl-2-thiouracil*	7	1·301	0·32	0·10	$<0·01$	0·289	0·13	0·04
8	4-Methyl-2-thiouracil *plus* vitamin A**	7	1·268	0·29	0·10	$<0·01$	0·260	0·12	0·04
6	4-Methyl-2-thiouracil *plus* vitamin A**	14	1·225	0·33	0·13	$\simeq 0·02$	0·278	0·11	0·05

* Dose: 0·33 mM a day each rat; ** dose: 24,000 I.U. a day each rat; † standard deviation, $S = \sqrt{\frac{\Sigma(X - \bar{X})^2}{N - 1}}$; †† standard error, $S_M = S/\sqrt{N}$; ††† probability of error, according to Fisher's "Statistical Methods for Research Workers".

nucleotide synthesis in the thiouracil liver, and combined medication of thiouracil with axerophtol results in no changes in the increase in ribose nucleic acid which is caused by the goitrogenic drug alone.

The increased formation of ribose nucleic acid demonstrates that methylthiouracil can be used for the biosynthesis of cytoplasmatic nucleotide by the liver cells. This fact appears to be in agreement with the observation of György, Rose and Goldblatt[6] on the protective action of the drug in liver cirrhosis of dietary origin, and with recent findings relating to the nucleotide formation from pyrimidines reported by Bergström, Hammarsten *et al.*[7].

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A Phosphoprotein in the Lens of the Eye

In previous work, we demonstrated the presence of ribonucleic acid in the lens[1]. In the course of this research we observed the existence, in the residue from the trichloracetic and lipid extraction of lenses, of a phosphoprotein fraction clearly distinct from nucleic acid. We have applied the following methods of study to this phosphoprotein fraction.

Methods. (1) Slow alkaline hydrolysis after trichloracetic acid and lipid extraction, according to the technique of Schmidt and Tannhauser[2] slightly modified. The extraction of the acid-soluble phosphorus was continued until no phosphorus appeared in the washing fluids. The lipids were extracted using Kumagawa's apparatus, 8 hr. in alcohol and 4 hr. in boiling ether.

(2) Enzymatic hydrolysis by trypsin according to the technique applied by J. D. Sterling and G. M. Wishart[3] to casein. We used trypsin (Merck) and obtained a similar product from both the residue of trichloracetic acid and that of lipid extraction. We have studied comparatively the acid-soluble phosphorus liberated under our experimental conditions (pH 8·7, incubation at 37° for 3 hr.) by the substrate alone, by the solution of trypsin alone and by the substrate and trypsin together. Our preparation of trypsin having a ribonuclease action, we deduced from our results the acid-soluble phosphorus liberated by the preparation of trypsin after boiling for 10 min. in a water-bath. The amount of phosphorus liberated under these conditions is about one-fifth of the acid-soluble phosphorus appearing after the action of unheated trypsin. This fraction results from the hydrolysis of ribonucleic acid.

Results. Slow alkaline hydrolysis revealed the presence of 6·5–8 mgm. of phosphoprotein phosphorus per 100 gm. of fresh ox lenses (six experiments) and of 7·8–9·2 mgm. for the same quantity of sheep lenses (three experiments).

Enzymatic hydrolysis has shown 7·4–9·8 mgm. of phosphoprotein phosphorus per 100 gm. of fresh ox lenses (four experiments).

A study of fractions obtained by precipitation with different concentrations of ammonium sulphate has shown that about 80 per cent of the phosphoprotein is in the precipitate obtained by the use of 40–60 per cent saturated ammonium sulphate.

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The Aqueous Humour of the Eye and Histamine

In dealing with the problem of the presence of histamine in aqueous humour, Emmelin and Palm[1] state: "aqueous humour contains histamine in biologically active form". They give the amount of histamine as 40 gamma/lit. aqueous humour (mean value, rabbit). In a later study Emmelin[2] confirms these results. During some experiments on the effects of eye traumata on the chemistry of the aqueous humour, I made the following observations, which seem to indicate that the active principle found in normal aqueous humour is not histamine. The histamine action was measured on the isolated gut of guinea pig according to the method of Minard (1941).

If aqueous humour was aspirated from a rabbit's eye and immediately transferred to the isolated gut, there was either no reaction at all or a contraction, starting after a latent period of 1–2 min. This contraction, caused by the application of aqueous humour, was of a considerably slower type than the histamine contraction, often taking several minutes to reach its maximum. In no case was a response of the typical

histamine form (almost immediate and very steep contraction) obtained.

If the aqueous humour is not transferred to the gut immediately after collection, but is left at room temperature for 5–15 min., the onset of contraction is less delayed, and the contraction reaches its maximum in a shorter time.

If the aqueous humour is left for two to three hours at room temperature, it often causes an immediate onset of a rapid contraction, which is very similar to the histamine effect. The height of the contraction corresponded to amounts of histamine of the same order of magnitude as those found by Emmelin and Palm, and by Emmelin.

My first impression that this phenomenon was due to the liberation of histamine from an inactive complex found no justification. Addition of 'Neoantergan' to a final concentration of $1:4 \times 10^6$ did not influence the contraction caused by aqueous humour 2·5 hr. old, whereas it completely abolished the effects of a corresponding amount of histamine.

This subject will be more fully described in *Acta Ophthalmologica*.

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The Provitamin D in Clams

THE communication on the "Conversion of Cholesterol to Provitamin D_3 *in vivo*" by Mary Scott, J. Glover and R. A. Morton in *Nature* of April 2, p. 530, prompts us to publish our results for the provitamin in clams. In order to obtain experimental evidence for the hypothesis that the provitamin D is essentially of endogenous origin, we investigated several years ago the sterols of the viscera and of the eviscerated body of clams. At the time when the clams were collected (late summer) their intestinal tract was filled with a dark green paste, indicating that the food consisted predominantly of chlorophyll-bearing micro-organisms such as algæ. The sterols isolated from the viscera contained 21·4 per cent provitamin D (determined spectroscopically and calculated as ergosterol). On the other hand, the sterols from the eviscerated body contained only 7·8 per cent provitamin D. Based on the weight of the fresh material, the viscera contained 0·0418 per cent provitamin D and the eviscerated body 0·0163 per cent. The total provitamin D content of the clams was found to be 0·019 per cent, and 24 per cent of the total provitamin D was in the viscera.

In order to gain information as to the chemical nature of the provitamin D in clams, identical amounts of provitamin D in the crude sterol fractions were irradiated with ultra-violet light, and the vitamin D formed was dissolved in identical amounts of corn oil and tested for antirachitic activity both on rats (two experiments) and on chicks. The results obtained are summarized in the accompanying table:

	1. Rat test U.S.P. units/gm.	2. Rat test U.S.P. units/gm.	Chick test A.O.A.C. units/gm.
Irradiated provitamin D from viscera	1,450	1,500	1,500±100
Irradiated provitamin D from eviscerated body	1,300	1,400	1,400±100

We have interpreted these findings as indicating that there is no difference in the type of provitamin D present in the viscera and the eviscerated body. We are also inclined to assume that they lend additional weight to the working hypothesis that the provitamin D is of endogenous origin. If a substantial part of the provitamin D present in the viscera had been of exogenous origin, we would have expected to find a lower 'chick' efficiency for the vitamin D prepared from the provitamin from the viscera than for the vitamin D prepared from the eviscerated body. Finally, we conclude that the provitamin D present in clams is neither pure ergosterol nor pure 7-dehydrocholesterol. If the provitamin were essentially ergosterol, we should have obtained a considerably lower activity for chicks than for rats, and if the provitamin were essentially 7-dehydrocholesterol we should have obtained a considerably higher 'chick' activity[1]. Our results leave open the question whether the provitamin D in clams is a mixture of ergosterol with 7-dehydrocholesterol or a new provitamin D, or a mixture of various known and unknown provitamins D.

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Shock and Mitotic Activity in Mice

IT has been argued that the concentration of sugar (or glycogen) within a tissue is a critical factor in controlling the rate of mitosis[1]. An abundance of sugar induces active cell division, while a sugar deficiency results in mitosis depression. Such a depression follows treatment with insulin, which lowers the blood sugar level; phloridzin, which interferes with phosphorylation; and starvation, which depletes the carbohydrate reserves of the whole body.

It was therefore considered of interest to discover the effect of ischæmic shock on mitosis, since there are indications that sugar metabolism is profoundly affected in this condition; moreover, it is also known that there is a gradual, and ultimately a profound, fall in the oxygen consumption of the body at such a time[2].

A series of experiments has now shown that during the initial stages of ischæmic shock the rate of mitosis is deeply depressed. A typical experiment demonstrating this is summarized in the accompanying table in which two groups, each of five adult male *CBA* mice, are compared. The first group was an untreated control; but in the second, shock was induced by the application to both hind legs of tourniquets (six turns of a rubber band of size 29), which were removed two hours later at 12.00 hr. The rate of mitosis was measured in the ear epidermis by the removal of pieces of ear at intervals from 10.00 hr.

The figures show that mitotic activity in the experimental mice fell rapidly to zero after the removal of the tourniquets at 12.00 hr. In the control mice, on the other hand, the mitosis-rate rose to a maximum at about 13.00 hr., which is a phenomenon associated with the early afternoon sleep period[3]. In normal

circumstances the maximum activity is still higher, and is not reached until about 14.00 hr. The fact that this did not happen in the present control animals was undoubtedly due to the interference with their rest caused by the removal of pieces of ear at 15-min. intervals.

Average numbers of mitoses per unit length (1 cm.) of sections of ear epidermis (cut 7 μ thick) from control mice and from mice which were shocked at 12.00 hr. by the removal of tourniquets from both hind legs

Time of day	Control mice		Shocked mice	
	Numbers of mitoses	Phases of division	Numbers of mitoses	Phases of division
10·00	2·1 ± 0·17	. . . *T*	2·3 ± 0·12	. . . *T*
12·00	3·7 ± 0·20	*P M* . .	2·6 ± 0·16	*P M* . .
12·15	4·1 ± 0·15	*P M* . .	2·4 ± 0·18	*P M* . .
12·30	4·6 ± 0·24	*P M* . .	2·1 ± 0·25	. *M* . .
12·45	5·0 ± 0·31	*P M A* .	2·4 ± 0·16	. *M A* .
13·00	5·6 ± 0·26	*P M A T*	2·4 ± 0·19	. *M A T*
13·15	5·2 ± 0·29	*P M A T*	2·2 ± 0·20	. . *A T*
13·30	4·5 ± 0·21	. *M A T*	1·6 ± 0·14	. . . *T*
13·45	4·1 ± 0·15	. *M A T*	0·7 ± 0·11	. . . *T*
14·00	3·6 ± 0·18	. . *A T*	0	. . . .

In the phases of division, *P* represents the prophase, *M* the metaphase, *A* the anaphase, and *T* the telophase.

However, the most interesting and significant part of the observations concerns the manner in which the mitotic activity fell in the shocked mice after the release of the tourniquets. At 12.00 hr. the rate of cell-division was increasing in both the control and the experimental mice, so that the mitoses counted were all in the pro- and metaphases. By 12.30 hr. no prophases remained in the shocked mice, and it is evident that no more developed. However, it appears that those mitoses which were already in existence at 12.00 hr. were completed at about the normal speed, the last of them finishing about 1¾ hours after the removal of the tourniquets. In contrast, the control mice continued to develop new mitoses until 13·15 hr., and, but for the disturbance of the experiment, would probably have continued to do so for some further time.

It has been noted in earlier experiments with insulin that conditions of acute sugar lack have little, if any, effect on the rate of completion of a division once it has started. Their effect is only to hinder the transition from interphase to prophase. In ischæmic and adenosine triphosphate shock the blood-sugar level is raised, sometimes profoundly, for variable periods during the first few hours after release of the tourniquets, but a coincident fall in the total oxygen consumption indicates that less sugar is being oxidized.

If the function of sugar is to supply the energy needed for division, then it is clear that by far the greater part of this energy is expended at the beginning of the division, and from other results (to be published) it appears that the number of resting cells entering division at any moment is in direct proportion to the amount of sugar being oxidized.

Evidence has also been obtained that adenosine triphosphate, which is a shock-inducing agent[4,5], has a similar effect on mitosis to that which follows the release of limb tourniquets. Present indications are that the effect is not quite so pronounced, but further work with a wider range of doses is required. In view of the key position of the adenine nucleotides in sugar metabolism, there may here be a clue to the mechanism of the shock-inducing action of extracellular nucleotide. It appears probable, because of the rapid onset of the phenomenon, that the factors responsible for the inhibition of mitosis are metabolites from the ischæmic limb. The chemical natures of these substances, if they can be determined, should prove to be of considerable interest.

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Use of Thin Films of Sublimate for Absorption Spectroscopy

We have previously described[1] a method for the preparation by sublimation of thin films of polar materials for use in low-temperature spectroscopy. Similar films have been used by Brown and Randall[2] for the same purpose, and by Blout and Fields[3] for infra-red absorption spectra. Our continued study of the spectra of such films has revealed certain anomalies which should be given proper consideration in their analysis.

It has been found with films of certain substances—of which uracil has been most carefully studied—

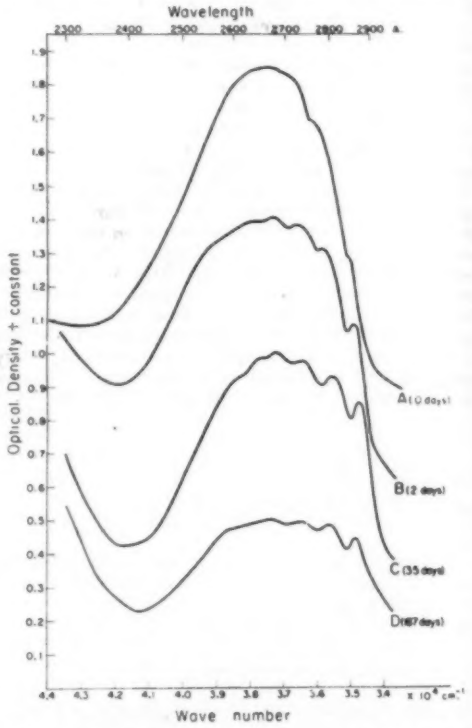
Wavelength
2300 2400 2500 2600 2700 2800 2900 Å
Optical Density + constant
A (0 days)
B (2 days)
C (35 days)
D (67 days)
4.4 4.3 4.2 4.1 4.0 3.9 3.8 3.7 3.6 3.5 3.4 × 10⁴ cm⁻¹
Wave number

Fig. 1. Uracil, sublimed films. Absorption spectra at 77° K. at the times indicated after sublimation. Optical densities normalized to 1 and separated by added constants. Following are the respective normalizing fractions and added constants. Curve *A*, 0·73, + 0·85; curve *B*, 1·1, + 0·4; curve *C*, 0·54, + 0; curve *D*, 0·69, − 0·5

that their low-temperature absorption spectrum changes with time on standing at room temperature under laboratory conditions. Thus in Fig. 1, curve *A* represents the absorption spectrum (normalized) at 77° K. of a uracil film, immediately (within ten minutes) after preparation by sublimation, curve *B* represents the spectrum of a similar film which has stood in the laboratory for two days after sublimation, while curve *C* represents the spectrum of a film 35 days, and curve *D* six months after sublimation. Solutions in buffer of the material on these films all gave the usual uracil spectrum, indicating that no molecular decomposition had taken place. It is evident that the vibrational fine structure, which is barely detectable in the freshly sublimed film, is gradually developed over a period of several days, and then is rather effaced on prolonged standing. Coincident with these low-temperature spectrum changes, the films, which are initially transparent, become visibly cloudy.

On the other hand, if the films are kept under vacuum, or over calcium chloride in a desiccator, these spectral changes are not observed and the films remain transparent. It would appear, then, that the presence of water vapour is necessary for this effect.

Several explanations may be advanced for this phenomenon. The water may facilitate the aggregation of the uracil film into small crystals, and it may be the uracil molecules within the ordered arrangement of these crystals that give rise to the vibrational structure evident in the spectrum. As the crystals increase in size, they could become large enough to scatter visible light, giving rise to the cloudy appearance, and the same scattering would be responsible for the effacement of the fine structure and decrease in maximum–minimum ratio in the oldest film. The formation of a uracil hydrate or the establishment, in the presence of water, of an altered tautomeric equilibrium are other possible causes.

Concurrent changes have also been observed in the infra-red absorption spectra of uracil films (on rock salt plates). Fig. 2 indicates the position and relative intensity of the infra-red absorption bands of a freshly sublimed uracil film and the bands of the same film after standing seven days in the laboratory. The fundamental effect here is a narrowing and intensification of the infra-red bands, with the consequent resolution of numerous bands previously merged into single broad bands. Again these changes are prevented if the film is stored in a desiccator.

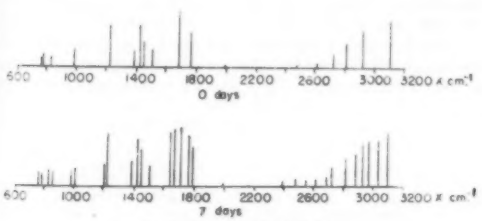

Fig. 2. Uracil, sublimed film

Similar changes in the low-temperature ultraviolet absorption spectra with time have been observed with films of adenine, guanine and tryptophane. Films of thymine, cytosine, *iso*cytosine, tyrosine and phenylalanine have not shown such effects.

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Phase Transitions in Boundary Films

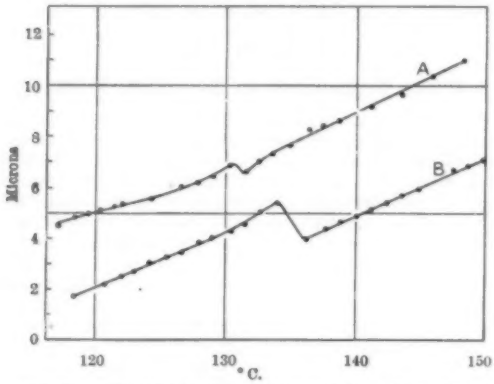
Bangham and co-workers[1], using charcoal blocks as adsorbents, found that the expansion accompanying adsorption of mobile films is proportional to the film pressure. Having established this, they were able to use the expansion of the block as a measure of the film pressure, and the method proved particularly suitable for detecting phase changes in the adsorbed films[2,3,4].

It may be shown that when a surface film melts (that is, the molecules of the film acquire free lateral mobility) there is a change in the film pressure, and it should therefore be possible to detect the melting of the film by the extensometric method. If one requires only to measure a critical *temperature*, a linear relation between film pressure and expansion is no longer necessary, and a wider range of adsorbents may therefore be used. The method has some advantages over the electron diffraction method; it may be used when the adsorbate is volatile and when the film is covered by bulk liquid. The second advantage makes the method of particular interest in lubrication investigations, when it may be desired to know the melting point of a boundary film adsorbed from bulk oil.

We have made some preliminary experiments to find whether these dimensional effects accompanying film melting are large enough to be detected with simple apparatus. For a given film pressure the expansion varies inversely with the linear dimensions of the structural units of the adsorbent, and, for the first experiments, artefacts were made by moulding alumina powder into the form of rods (approximately 5 cm. × 1 cm. × 1 cm.) and then sintering to give sufficient strength for handling. By adsorption measurements it was found that the alumina had a surface area of 173 sq. metres/gm. accessible to water molecules and 50 sq. metres/gm. accessible to molecules of stearic acid. A capacity extensometer sensitive to about one-tenth micron was used. Films were adsorbed by soaking the dried artefact for about twenty-four hours in a solution of fatty acid in benzene. After draining and allowing the benzene to evaporate, the artefact was heated in the extensometer.

Stearic acid, ($C_{17}H_{35}COOH$), palmitic acid, ($C_{15}H_{31}COOH$), and myristic acid, ($C_{13}H_{27}COOH$), were used, and twenty-one capacity–temperature curves were determined for these films. In each

instance a discontinuity was observed at a temperature characteristic of the molecule adsorbed. Though the discontinuities were several times larger than the experimental error and always occurred at the same temperature (for a given adsorbate), the general shape of the capacity–temperature curves was not reproducible. It was afterwards learned that twenty-four hours is not sufficiently long for the complete deposition of fatty acid film on this powder, and it was thought that the irreproducibility might arise from surface migration of the film after melting; a second experiment on the same artefact would then start with the film in a different configuration. It seems, moreover, that as the sense of the discontinuity is not always the same, there must be more than one mechanism of mechanical interaction between the film and the adsorbent.



Zinc stearate on cupric oxide. (*A*) 24 hours allowed for deposition of film; (*B*) 7 days allowed for deposition of film

To throw additional light on the question of migration, some experiments were then made using a sample of cupric oxide powder, on which it had been found that the adsorption is completed more quickly. A quartz extensometer which gave a linear relation between the extensometer reading and the expansion was also used in place of the capacity extensometer, which was non-linear. More definite results of the kind shown in the accompanying graph were then obtained; each curve was of the same general character with a discontinuity at a fairly well-defined temperature. Even so, successive runs usually gave curves slightly displaced with respect to one another, and it appears difficult to deposit a film sufficiently perfect for successive experiments to give curves which can be superposed. However, this lack of perfect reproducibility, taken together with the nature of the earlier results, offers strong presumptive evidence that the discontinuity is the result of an actual melting of the surface film; a mere molecular disorientation without lateral movement could scarcely lead to irreproducible results.

The design of the capacity extensometer made it particularly suitable for studying the behaviour of adsorbed films when in the presence of bulk solution, and some results were obtained using alumina artefacts immersed in solutions of stearic, palmitic and myristic acid, respectively, in benzene. Again, discontinuities were observed.

Adsorbent	Adsorbate	Melting point (° C.)	Temperature of discontinuity (° C.)	
			Dry film	Immersed in benzene
Alumina	Stearic acid	69	69	60
,,	Palmitic acid	63	54	29
,,	Myristic acid	58	44	23
Cuprous oxide	Methyl stearate	38	41	
Cupric oxide	Methyl stearate	38	42	
,, ,,	Ethyl stearate	30, 33	36, 39	
,, ,,	Glycol distearate	62, 76	65	
,, ,,	Zinc stearate	130	130	
,, ,,	Calcium stearate	180	185	

Where two figures are given for the melting point, the former is the measured value, the latter is the published figure. For methyl stearate there was insufficient sample remaining for a melting point determination. In all other cases, the measured and published figures agree

The accompanying table lists the results which have so far been obtained. The tentative conclusions which may be drawn from them are: (1) The discontinuity represents a melting of the film. (2) For soaps, esters and acids which do not react with substrate, there is little difference between the bulk melting point and the melting point of the monomolecular film for the molecules of greatest chain-length. (3) As the chain-length decreases, the melting point of the film falls farther below the bulk melting point. (4) The presence of superincumbent solvent lowers the melting point of the film.

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[1] Bangham and Fakhoury, *J. Chem. Soc.*, 1324 (1931).
[2] Bangham, Fakhoury and Mohamed, *Proc. Roy. Soc.*, A, 138, 162 (1934).
[3] Bangham, Fakhoury and Mohamed, *Proc. Roy. Soc.*, A, 147, 152 (1934).
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Electrical Co-operative Effects in Crystalline Long-Chain Secondary Alcohols

It has been shown[1] that, in polar solids, short-range forces may cause a very high energy difference V between equilibrium positions of the dipoles, and, at temperatures where $kT \ll V$, dielectric absorption of the Debye type may be negligible. Experimental results[2] show that this theory applies to several crystalline long-chain ketones at room temperature. Although these compounds gave negligible absorption at radio frequencies, high dielectric loss was observed

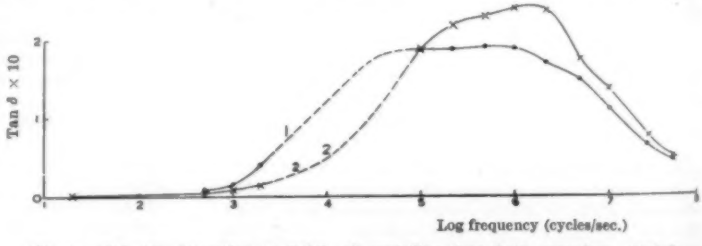

Fig. 1. Dielectric absorption at 20° C. of crystalline long-chain secondary alcohols. (1) 14-Heptacosanol; (2) 16-hentriacontanol

at low frequencies (50–1,000 c./s.), the loss angle increasing, in each case, with decreasing frequency and with decreasing chain-length of the molecules. This absorption was considered to be due to short-range interaction, which causes the dipoles to reverse their direction in groups. Such interaction has been shown theoretically to lead to enhanced polarization[2] and absorption, and to shift the absorption peak to lower frequencies[4].

Preliminary dielectric measurements have now been made with a number of crystalline long-chain secondary alcohols, the variation of loss angle with frequency for 14-heptacosanol ($C_{13}H_{27}.CHOH.C_{13}H_{27}$) and 16-hentriacontanol ($C_{15}H_{31}.CHOH.C_{15}H_{31}$) being shown in Fig. 1. Similar results were obtained with a number of other crystalline secondary alcohols of chain-length between 15 and 43 carbon atoms. In contrast to the ketones, it was found that the dielectric absorption was not displaced to lower frequencies with increasing chain-length. This suggests that it may not be associated with rotation of the molecules, but may result from orientation of the hydroxyl groups by rotation about the C—O bond, with two positions of equilibrium stabilized by H-bonding (see Fig. 2). The wide frequency-range of the absorption is presumably due to the varying numbers of hydroxyl groups forming continuous chains. A similar mechanism of reversal of chains of dipoles has been suggested[3] as an explanation of the ferro-electric properties of Rochelle salt.

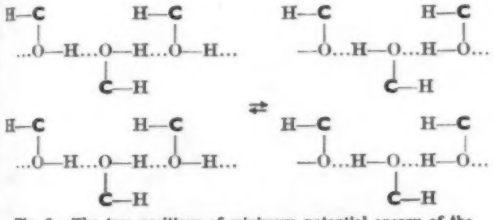

Fig. 2. The two positions of minimum potential energy of the hydroxyl groups in a crystalline secondary alcohol (section normal to molecular chains)

Support for this hypothesis was obtained from measurements with dilute (0·1 *m*) solid solutions of 14-heptacosanol in *n*-octacosane ($C_{28}H_{58}$) and 16-hentriacontanol in *n*-dotriacontane ($C_{32}H_{66}$). In such solutions the hydroxyl groups would be isolated and would give rise to an absorption peak at ultra-high frequencies. As expected, these solid solutions gave negligible dielectric loss throughout the frequency-range 90 kc./s.–50 Mc./s. The absence of an absorption peak similar to that found in solid solutions of ketones[4] may be due to the large size of the hydroxyl group opposing rotational transitions of the molecule as a whole.

More complete details of the results of this work will be published elsewhere.

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[2] Meakins, R. J. (In the press).
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Rheological Measurements and Adhesion

The work described by Dr. E. W. J. Mardles[1] may be considered in relation to our results on yield stresses in lubricating greases[2], which were determined under conditions of simple tangential shear. We presented evidence to show that at shearing stresses above a certain value (termed the 'first yield stress') flow of grease takes place by slip on a thin film of oil at the grease–solid interface. Flow as a result of breakdown of the bulk grease structure occurs only above a certain higher stress, which is the yield value commonly measured and is called by us the 'second yield stress'.

Following the views of Hardy, which are quoted by Dr. Mardles, we supposed that the first yield stress is due to the development of a rigid structure in the slip film of oil under the influence of adsorption forces, and that its magnitude might depend on the chemical nature of the surface in contact with the grease. Adsorption forces, which are considered to be responsible for the first yield stress, may also affect the thickness of the slip film of oil. Since in some of Dr. Mardles's experiments the possibility of slip appears to be excluded by the geometrical shape of his apparatus, it also seems possible that the adhesion forces may play a part in flow at stresses above the second yield stress involving breakdown of the grease structure.

Slip of the type described is, however, essentially a phenomenon occurring at interfaces, whereas in shear of the main grease structure most of the energy dissipation takes place at distances from the interfaces very great compared with the range of adhesion forces. The effect of the nature of the surface on the flow of the grease would, therefore, be expected to be particularly marked at shearing stresses intermediate in magnitude between the first and second yield stresses, and it is interesting to note that in Dr. Mardles's experiments (Fig. 1) the effects due to the nature of the surface become increasingly pronounced as the shearing stress diminishes with increase in penetration or radial flow.

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[1] Mardles, E. W. J., *Nature*, **164**, 324 (1949).
[2] Blott, J. F. T., and Bonnor, W. B., Proc. International Rheological Congress, **2**, 265 (1948).

Mixture Law for Viscosity

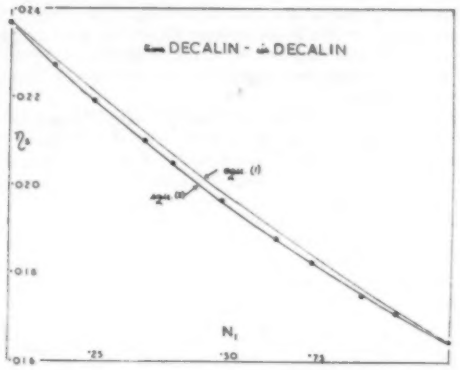
Arrhenius[1] proposed the following expression for the viscosity of a solution:

$$\log \eta_s = N_1 \log \eta_1 + N_2 \log \eta_2, \qquad (1)$$

where η_s is the viscosity of the solution; N_1 and η_1 are the mole fraction and the viscosity of component 1; N_2 and η_2 the mole fraction and the viscosity of component 2. However, both positive and negative deviations from this equation are found to occur. From a comparison of vapour pressures and viscosities of solutions, we deduced that in many cases the following equation yields closer agreement with experimental results:

$$\log \eta_2 = N_1 \log \eta_1 + N_2 \log \eta_2 + N_1 N_2 . d, \quad (2)$$

where d is a characteristic constant of the system. The accompanying graph shows curves calculated according to equations 1 and 2 (with $d = -0{\cdot}0224$) for the system *trans*-decalin–*cis*-decalin. The points on the graph represent the experimental results of Bird and Daly[2].



The constant d can assume both positive and negative values. We found that d is positive for systems showing a negative deviation from Raoult's law, and is negative for systems showing a positive deviation from Raoult's law. d is connected with the constant b in the simplified Margules equation $\log \gamma_1 = bN_2^2$ (where γ_1 is the activity coefficient of component (1)) by the equation

$$d = C \,.\, b. \quad (3)$$

C is the ratio log viscosity to log vapour pressure. The fact that C is always negative agrees with the antiparallelism usually found between the viscosity and the vapour pressure of solutions.

Full results of our investigations will be published elsewhere.

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Action of 2.3.5-Triiodobenzoic Acid on Growth of Root Hairs

Zimmermann and Hitchcock[1] found 2.3.5-triiodobenzoic acid to be active as a 'formagen', that is, a substance affecting flowering and growth processes in the tomato. In the *Avena* coleoptile standard test, this compound acts as an anti-auxin[2], inhibiting the action of indole-3-acetic acid. The present communication deals with the influence of 2.3.5-triiodobenzoic acid on the growth of root hairs, these organs being used as a test object to investigate the growth of a single cell and the growth and structure of cell walls.

Fig. 1. Tips of root hairs, treated with 2.3.5-triiodobenzoic acid. Note the cellulose masses hanging at the tip

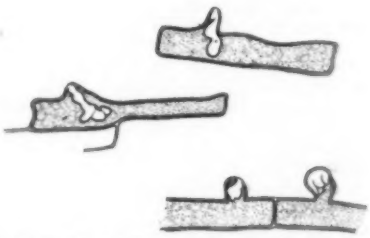

Fig. 2. Epidermal cells with root hair initials. No longitudinal growth; formation of cellulose masses at the tip

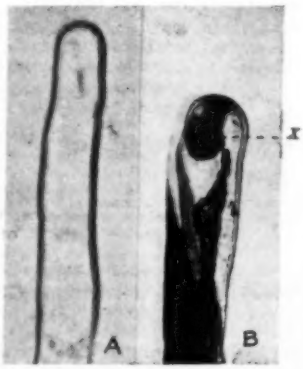

Fig. 3. *A*, normal root hair tip. *B*, tip of a root hair, treated with 2.3.5-triiodobenzoic acid, with cellulose mass at *X*. Preparation stained with chlor-zinc-iodine to demonstrate the cellulose mass

Seeds of *Lepidium sativum* were germinated upon porous plates soaked with a 0·02 per cent solution of 2.3.5-triiodobenzoic acid. The root hairs develop to a certain extent and then stop growing. Longitudinal growth comes to a stop, but other processes go on, including the formation of cell-wall material. This cell-wall material, instead of being used for the growth of the cell-wall, is accumulated at the tip of the root hair, forming an irregular mass hanging from the tip inside the cell. This is shown in Figs. 1 and 2 and in the photograph (Fig. 3). The material gives the usual cellulose reactions and has no birefringence. We may suppose that it consists for the greater part of cellulose.

It is concluded that 2.3.5-triiodobenzoic acid inhibits the use of cell-wall material for its usual purpose.

which is normally followed by a longitudinal growth of the cell. Instead of this, the material remains as a mass with undirected micelles at the place where it is formed (namely, the tip of the root hair, where normally growth takes place). It seems probable that this property of 2.3.5-triiodobenzoic acid is responsible for its activity as a 'formagen'.

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[2] Waard, J. de, and Florschütz, P. A., *Proc. Kon. Ned. Akad. Wetensch. Amsterdam*, **51**, No. 10 (1948).

Zinc Deficiency of Fruit Trees in Britain

ZINC deficiency of fruit trees, which was first recognized by Chandler *et al.*[1] in 1931, has since been reported as a serious trouble in many of the important fruit-growing countries of the world, particularly in the United States[2] and Australia[3,4,5]. In Europe, instances have been reported in Hungary[6], Holland, Denmark and Switzerland[7]. Affected fruits have included *Citrus*, apples, pears, most stone fruits, walnuts, grapes and pecans, the deficiency being especially widespread in all *Citrus* fruits.

Affected trees develop very striking growth features which have given rise to the descriptive names of 'little leaf', 'rosette' and 'mottle leaf' (this last applied to *Citrus*). The little leaf and rosette conditions are well developed in apples, pears and stone fruits, and serve as useful diagnostic features of the trouble.

A serious deficiency of zinc in fruit trees has not hitherto been shown to occur in Great Britain, although Roach and Barclay[8] recorded increased yields in cereals and potatoes from zinc sprays on soils in Romney Marsh, also deficient in manganese, and Thompson and Roberts[9] obtained some response to injections of zinc in sweet cherries, which were considerably improved by injections of iron plus manganese and for which zinc was considered "a minor and perhaps unimportant deficiency".

In July 1948 our attention was directed to a serious failure of apple trees on a plot used in the National Fruit Trials at the Royal Horticultural Society's Gardens, Wisley, and we have been able to show that the main cause of the failure is an acute deficiency of zinc. The trees also show symptoms of magnesium deficiency, and this may be a contributory cause to the deficiency of zinc[2]. The site is low-lying and level, and the soil is a coarse sand and gravel overlying deep gravel. The *p*H value (following liming treatment to correct acidity in 1943–44) from the surface to below 12 in. depth ranges from 7·2 to 6·8, and available phosphate (soluble in 1 per cent citric acid) is fairly high from 0·059 to 0·022 per cent. Zinc extracts in the surface soil (0–6 in. depth) gave the following values:

N Ammonium acetate at *p*H 7·0	=	1·31 p.p.m.
N/10 Hydrochloric acid " *p*H 4·5	=	8·9 "
" " "	=	10·2 "

The orchard contains apples, pears and plums as bush and half-standard trees, all about twenty years old. The apples are mainly on Malling Nos. I and II rootstocks and the pears on seedling pear stocks. Attention so far has been mainly given to the apples,

Comparison of healthy (left) and zinc-deficient (right) apple foliage

as they have been most seriously affected, though recent inspection (May 1949) of the pears has shown that these are also acutely deficient and deteriorating rapidly.

Several varieties of apples occur in the worst area, among which two varieties, Laxton's Pearmain and Edith Hopwood, were selected for experimental treatments in 1948 as being outstanding for their poor condition.

On affected apple trees the shoots carry sparse foliage and show typical short internodal growths with leaf rosetting and shoot die-back; the leaves are much reduced in size and tend to be lanceolate, with wavy margins and diffuse intervenal chlorosis, often with a narrow dark-green marginal rim (see photograph). Shoots and spurs are markedly brittle and the bark of older growths somewhat rough. The condition of badly affected pears is similar to that described for the apples, though leaf characters may differ in detail. A striking feature in the pears is the large proportion of dead bark tissue on the main stems.

The preliminary diagnosis of the trouble in the apples as zinc deficiency was made from the visual symptoms on July 1, 1948, and this has been since confirmed by spray and injection treatments with zinc sulphate, analysis of leaves and bark tissues from affected and healthy trees and soil tests for zinc on surface soil samples from affected and healthy areas, using *Aspergillus niger* as a test organism[10].

Spraying treatments with zinc sulphate, copper sulphate and manganese sulphate, as single and combined sprays applied on July 6, 1948, gave preliminary evidence of response only to zinc on August 23, 1948, and further spray and injection treatments during the dormant season with these three compounds have given marked responses to zinc but no visible effects from the other two compounds. The most effective treatments with zinc have resulted

Zinc content of leaves and shoots from healthy and affected trees

Variety	Plant portion tested	Zn as μgm. per gm. or p.p.m. in dry matter
Laxton Pearmain (healthy)	Leaf	9·6
Laxton Pearmain (little leaf)	"	1·2
Edith Hopwood (little leaf)	"	2·3
" " " (" ")	"	1·6
Lord Hindlip (healthy)	Bark	10·8
" " (little leaf)	"	2·1

in the production of normal growths of shoots and leaves.

The results of chemical tests for zinc on leaves and shoots from comparable healthy and affected trees on the plot are given in the accompanying table.

A comparison of results obtained in *Aspergillus* tests on surface soils from a healthy apple plantation at Long Ashton and the affected plantation at Wisley is shown below.

Long Ashton soil	10 μgm. Zn per gm. air-dry soil
Wisley soil	1–2 μgm. ,, ,,

The proof of a serious zinc deficiency problem in this Wisley soil, which has been treated in accordance with the usual manurial practice recommended for commercial fruit plantations, raises the question as to the extent to which zinc deficiency may be a limiting factor to tree growth on the widespread sand and gravel deposits of the surrounding district.

The experiments are being continued on apples, pears and stone fruits, and will be reported fully elsewhere.

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[1] Chandler, H. W., Hoagland, D. R., and Hibbard, P. L., *Proc. Amer. Soc. Hort. Sci.*, **28**, 556 (1931).
[2] Camp, A. F., *Soil Sci.*, **60**, 157 (1945).
[3] Kemp, H. K., and Beare, J. A., *J. Dept. Agric. S. Aust.*, **47**, 470 (1944).
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[5] Ward, K. M., *Quart. J. Agric. Sci.*, **1**, 59 (1944).
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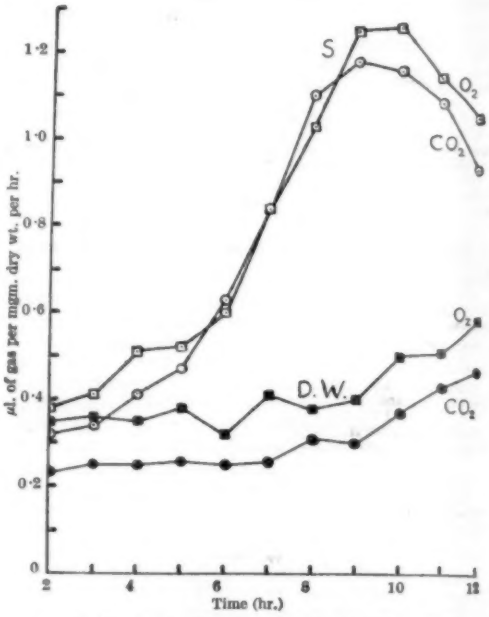
[10] Nicholas, D. J. D., and Fielding, A. H., Long Ashton Res. Stat. Ann. Rep. 126 (1947).

Effect of the *Striga* Germination Stimulant on the Respiration of *Striga* Seeds

It has been shown previously[1] that the natural stimulating substance which promotes the germination of the seeds of *Striga hermonthica* is capable of causing extension growth of pea root segments. Should this be the only function of this stimulating substance in the germination process of the seeds of *Striga hermonthica*, then it is difficult to account for some of its effects on *Striga* seeds.

Thus, when air-dry seeds of *Striga hermonthica* were treated with a solution of the stimulating substance, I found that subsequent germination under optimum conditions was almost completely inhibited. The nature of this inhibition has not yet been fully established; but several replicated experiments have shown that the stimulating solution has a marked effect on the respiration of *Striga* seeds. The accompanying figure shows the respiration of *Striga* seeds during a 12-hour period after the addition of distilled water, and after the addition of the stimulating solution to air-dry seeds. It will be seen from this figure that the respiration of the seeds is markedly enhanced when they are placed in the stimulating solution, compared with that when they were in distilled water. This increase in the rate of respiration takes place at the expense of the sugar reserves of the seeds.



S, Respiration in the stimulating solution at 32° C.; *D.W.*, respiration in distilled water at 32° C.

The respiration of the seeds of *Striga hermonthica* is also enhanced by the stimulating solution when the seeds are able to germinate. I first observed this during certain experiments in which 50 per cent of the seeds were induced to germinate after six days of moisture-treatment at 22° C., followed by exposure to the stimulating solution for forty-eight hours at 32° C. Studies on the respiration of the seeds during the first twelve hours of exposure to the stimulating solution, together with chemical analysis, showed that in this case the substrate for respiration is protein, and that there is no decrease in the rate of respiration after twelve hours.

Subsequent experiments have shown that the stimulating solution increases the rate of respiration of *Striga* seeds when they are treated with it after prior exposure to moisture for various times at various temperatures. Furthermore, I have not been able to correlate the increase in respiration due to the stimulating solution with the germination capacity of the seeds at any stage of after-ripening or moisture-treatment.

It seems, therefore, that the *Striga* germination substance enhances the rate of respiration of the seeds, as well as possibly causing root-extension under optimum conditions.

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June 3.

[1] Brown, Robinson and Johnson, *Nature*, **163**, 842 (1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 7

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. W. E. Van Heyningen: "Bacterial Toxins".* (Further Lectures on November 14, 21 and 28.)

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Prof. D. L. Linton: "Graded Rivers".

ROYAL INSTITUTE OF CHEMISTRY, MANCHESTER AND DISTRICT SECTION (in the Lecture Hall, Central Library, Stockport), at 7 p.m.—Dr. G. N. Dyson: "A System of Chemical Nomenclature".

Tuesday, November 8

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. T. Burton Brown: "Evidence from Azerbaijan regarding the coming of the Indo-Europeans".

UNIVERSITY OF LONDON (in the Geology Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 5.30 p.m.—Prof. T. Barth (Oslo): "New Principles in the Study of Geochemical Cycles"*. (Further Lecture on November 10.)

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS, at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Conference on "Heat Transfer at Low Temperatures".

INSTITUTION OF WORKS MANAGERS, MERSEYSIDE BRANCH (at the Exchange Hotel, Liverpool), at 6.30 p.m.—Mr. W. S. Vick: "Incentives".

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Lieut.-Colonel E. J. Claridge: "Nigeria, my Land of Adoption".

INSTITUTION OF WORKS MANAGERS, LEICESTER BRANCH (at the College of Technology, St. George's Avenue, Northampton), at 7 p.m.—Mr. L. C. Ord: "American Production Methods".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. R. A. Shaw: "Resonance in Aerodynamics".

Monday, November 7—Tuesday, November 8

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m. and 5.30 p.m.—Symposium of Papers on "Ferromagnetic Materials"

Wednesday, November 9

CHEMICAL SOCIETY, MANCHESTER SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Department, The University, Manchester), at 10.30 a.m., 2.30 p.m. and 5.15 p.m.—Symposium on "Some Chemical Aspects of Atomic Energy" (to be introduced by Dr. R. Spence).

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (joint meeting with the NATIONAL SMOKE ABATEMENT SOCIETY, at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. W. F. Howell: "Industrial Gas in the Manchester District".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Bengt Strömgren: "The Properties of Matter in Interstellar Space".* (Further Lectures on November 10 and 14.)

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. E. Voce: "Recent Developments in Copper and Copper Alloys".

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH-EAST SCOTLAND SUB-CENTRE (at the Caledonian Hotel, Aberdeen), at 7.30 p.m.—Discussion on "Education for Engineering" (to be opened by Dr. E. Wilkinson, Mr. H. J. Revell and Mr. R. T. Pirie).

Thursday, November 10

INSTITUTION OF WORKS MANAGERS, WEMBLEY SUB-BRANCH (at the Rest Hotel, Kenton), at 12.30 p.m.—Mr. J. C. Cornwell: "Piercing Diamonds for Drawing Wire".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Discussion on "Detonation" (to be opened by Dr. W. G. Penney).

MINERALOGICAL SOCIETY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

CHEMICAL SOCIETY, NORTH WALES SECTION (joint meeting with the UNIVERSITY COLLEGE OF NORTH WALES CHEMICAL SOCIETY, in the Department of Chemistry, University College of North Wales, Bangor), at 5.30 p.m.—Prof. Wilson Baker, F.R.S.: "A New Type of Aromatic Compound".

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. W. Cox and Mr. W. E. Swale: "Electricity in the Cotton Industry".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Lecture Hall, Trinity College of Music, Mandeville Place, London, W.1), at 5.30 p.m.—Mr. Llewellyn S. Lloyd: "Concert Pitch".

CHEMICAL SOCIETY, HULL SECTION (joint meeting with the UNIVERSITY COLLEGE SCIENTIFIC SOCIETY, in the Science Lecture Theatre, University College, Hull), at 6 p.m.—Prof. N. K. Adam, F.R.S.: "Surface Films".

ILLUMINATING ENGINEERING SOCIETY, MANCHESTER CENTRE (joint meeting with the MANCHESTER AND DISTRICT BRANCH of the INSTITUTE OF PHYSICS, in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Prof. H. Hartridge, F.R.S.: "Recent Advances in the Physiology of Colour Vision".

CHEMICAL SOCIETY, NOTTINGHAM SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Lecture Theatre, Chemistry Department, The University, Nottingham), at 6.30 p.m.—Prof. M. Stacey: "Organic Compounds of Fluorine".

WOMEN'S ENGINEERING SOCIETY (at 35 Grosvenor Place, London, S.W.1), at 7 p.m.—Discussion on "Women and Mechanical Engineering".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Mr. T. C. Denston: "The British Pharmaceutical Codex, 1949".

Friday, November 11

MINERALOGICAL SOCIETY, CLAY MINERALS GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 10 a.m.—Discussion on "The Less Common Clay Minerals".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF WORKS MANAGERS, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. W. Hendry: "Man-hour Output—Time Study's Contribution".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Dr. D. W. Adamson: "The Chemistry of Antihistamine and Related Drugs".

CHEMICAL SOCIETY, ABERDEEN BRANCH (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY in the Chemistry Department, Marischal College, Aberdeen), at 7.30 p.m.—Prof. E. R. H. Jones: "Acetylene and Acetylenic Compounds in Organic Synthesis" (Tilden Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. A. G. Gaydon: "Flame Spectra".

Thursday, November 10—Friday, November 11

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1), at 10 a.m. each day.—Autumn General Meeting.

Saturday, November 12

BIOCHEMICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Scientific Papers.

INSTITUTE OF PHYSICS, SOUTH WALES BRANCH (at the University College, Cardiff), at 2 p.m.—Mr. H. P. Rooksby and Mr. E. G. Steward: "Industrial Applications of X-Ray Analysis".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMIST, to work on insecticide problems in London—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (November 12).

ASSISTANT VETERINARY INVESTIGATION OFFICER—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (November 12).

ASSISTANT CHEMIST—The Chief Engineer, Middlesex Main Drainage Department, Isleworth, Middx., quoting G.201.T (November 12).

VETERINARY RESEARCH OFFICER (Scientific Officer grade)—The Director, Agricultural Research Council's Field Station, Compton, Newbury, Berks (November 12).

ASSISTANT IN THE ABSTRACTING AND TRANSLATION SECTION of the Secretary's Department in London—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, endorsed AE/35 (November 14).

LABORATORY ASSISTANT IN THE DEPARTMENT OF AGRICULTURE (Agricultural Zoology)—The Secretary and Registrar, University College of North Wales, Bangor (November 14).

SENIOR ENGINEERING ASSISTANT—The Engineer and Works Manager, Engineer's Office, Wey Valley Water Company, Hindhead, Surrey (November 14).

ASSISTANT (male) IN THE SCIENTIFIC LIAISON SECTION—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (November 19).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSIOLOGY—The Registrar, The University, Liverpool (November 19).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Reading (November 24).

SCIENTIFIC OFFICER (with an Honours degree in mathematics or physics) in the Operational Research Section of the Ministry of Civil Aviation—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.257/49BN (November 26).

EXPERIMENTAL OFFICERS in Ministry of Supply Research and Development Establishments, chiefly in the Midlands and South England, in the following fields: Chemistry (Ref. F.563/49BN), physical, analytical (with special reference to modern techniques), organic, and chemical engineering; Metallurgy (Ref. F. 563/49 BN); Physics (Ref. A.398/48 BN), particularly in its application to electronic or engineering problems including instrumentation; Aerodynamics (Ref. C.12/49BN), including wind tunnel and flight work, subsonic and supersonic speeds; Aircraft Structural Theory (Ref. C. 12/49BN), including flutter and vibration, structural strength and air-worthiness; Instrumentation (Ref. C.12/49BN), including computing devices, control systems, etc.; Electronics (Ref. D.6/49BN), applications to general research needs and computing devices, etc.; Radio and Radar (Ref. D.6/49BN), particularly U.H.F. techniques, miniaturization aerial, etc.; Library and Technical Information (Ref. F.563/49BN) in any of the fields listed above—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (November 26).

LECTURER IN EDUCATIONAL PSYCHOLOGY—The Registrar, The University, Leeds 2 (November 28).

UNESTABLISHED POST IN THE FOOD SCIENCE ABSTRACT SERVICE under the Directorate of Food Investigation, Cambridge—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.737/49BN (November 30).

LECTURER IN BACTERIOLOGY at the Royal Infirmary, and a LECTURER IN PATHOLOGICAL BIOCHEMISTRY at Western Infirmary, Glasgow—The Secretary of University Court, The University, Glasgow (November 30).

LECTURER OR ASSISTANT LECTURER IN BOTANY, with special qualifications in Palæobotany—The Registrar, The University, Manchester 13 (November 30).

LECTURER IN CIVIL ENGINEERING (with special interest and experience in Hydraulics) at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 1).

LECTURER IN SOCIAL ANTHROPOLOGY—The Registrar, University Registry, Clarendon Building, Oxford (December 1).

PROFESSOR OF ZOOLOGY AND HEAD OF THE DEPARTMENT OF BIOLOGY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 5).

SCIENTIST (either Physicist or Chemist) as DIRECTOR OF THE CENTRAL RESEARCH ESTABLISHMENT at Stoke Orchard, near Cheltenham, to take charge of both fundamental and technical research—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/166 (December 8).

PROFESSOR and LECTURERS (3) IN THE FACULTY OF VETERINARY SCIENCE, University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 10).

SENIOR SCIENTIFIC OFFICERS (with a good Honours degree in engineering, physics or mathematics, and experience in the design of structures or fatigue testing of materials and structural elements) for aircraft research in Structures Division, Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.267/49BN (December 15).

LECTURER IN ENGINEERING THERMODYNAMICS at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 15).

PRINCIPAL SCIENTIFIC OFFICER (with a good Honours degree in physics, with good mathematical knowledge and research experience on radar display, digital and analogue computers, pulse and pulse-coded communications) at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.264/49BN (December 20).

ASSISTANT ELECTRICAL ENGINEER, a MECHANICAL ENGINEER, an ASSISTANT COMMUNICATION ENGINEER, COMMUNICATION TECHNICIANS, and ELECTRICAL DRAUGHTSMEN, with the New Zealand State Hydro-Electric Department—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (December 30).

DEMONSTRATOR IN THE DEPARTMENT OF ENTOMOLOGY—The Assistant Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1 (December 31).

SOIL CONSERVATION OFFICER in the Ministry of Agriculture, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Soil Conservation'.

CYTOLOGIST (Grade III)—The Professor of Genetics, The University, Birmingham 15.

DEMONSTRATORS (2) IN THE DEPARTMENT OF AIRCRAFT PROPULSION—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks.

ASSISTANT REGISTRAR—The Registrar, The University, Reading.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Britain's New Industry. Stanlow 1949. Pp. 80. (London: Shell Chemical Manufacturing Co., Ltd., 1949.) [197

Soviet Studies: a Quarterly Review of the Social and Economic Institutions of the U.S.S.R. Vol. 1, No. 1, June. Pp. 92. (Oxford: Basil Blackwell, 1949.) 7s. 6d. net; annual subscription, 25s. [118

British Institute of Management. Conference Series 10: Financial Information and Joint Consultation. Pp. 28. (London: British Institute of Management, 1949.) 2s. 6d. [118

Medical Research Council. Special Report Series, No. 183: Reports on Biological Standards, 3, Methods of Biological Assay depending on a Quantal Response. By J. H. Gaddum. Re-issue. Pp. 46. (London: H.M. Stationery Office, 1933.) 1s. net. [118

Iron and Steel Institute. Special Report No. 40: Atlas of Isothermal Transformation Diagrams of B.S. En Steels. Pp. 64. 25s.; to Members, 15s. Special Report No. 41: Corrosion of Iron and Steel by Industrial Waters and its Prevention. Pp. 56+9 plates. 5s.; to Members, 3s. 9d. Special Report No. 42: Report on the Bessemer Process. Pp. 80. 25s.; to Members, 15s. (London: Iron and Steel Institute, 1949.) [118

Air Ministry: Meteorological Office. Meteorology of Airfields. By C. S. Durst. (M.O. 507.) Pp. ii+87. (London: H.M. Stationery Office, 1949.) 2s. net. [118

Wilberforce House, Hull: its History and Collections. By J. B. Fay. Pp. 16+7 plates. (Kingston-upon-Hull: Mortimer Museum, 1949.) 6d. [118

Metropolitan Water Board. A Review of the Resources and Consumption of Water in the Greater London Area. By Prof. P. G. H. Boswell. Pp. 23+10 plates. (London: P. S. King and Staples, Ltd., n.d.) 10s. 6d. [128

Handbook of British Standards for Building Materials and Components for Housing. Addendum No. 2, 1949, to B.S. Handbook No. 3, 1947 edition. (P.D. No. 905.) Pp. 108. (London: British Standards Institution, 1949.) 5s. [128

Scientific Survey of North-Eastern England. Prepared for the Meeting held in Newcastle-upon-Tyne, 31st August to 7th September 1949. Pp. xiii+204. (Newcastle-upon-Tyne: British Association Local Executive Committee, King's College, 1949.) [158

Medical Research Council of Ireland. Annual Report for the Year ended December 31, 1948. Pp. 30. (Dublin: Medical Research Council of Ireland, 1949.) [158

Air Transport and Insects of Agricultural Importance. By Dr. W. A. L. David. Pp. 12. (London: Commonwealth Institute of Entomology, 1949.) 1s. 6d. [158

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 841, Vol. 242: The Disturbance due to a Line Source in a Semi-Infinite Elastic Medium. By E. R. Lapwood. Pp. 63–100. 9s. No. 842, Vol. 242: The Calculation of the Absolute Strengths of Spectral Lines. By D. R. Bates and Agnete Damgaard. Pp. 101–122. 7s. (London: Cambridge University Press, 1949.) [158

Organic Husbandry: a Symposium. Pp. 160. (London: Scientechnic Press, Ltd., 1949.) 2s. 9d. [158

British Institute of Management. Winter Proceedings, 1948–49, No. 6: The Management of Multiple Shops. By Alan J. Salmsbury. Pp. 36. (London: British Institute of Management, 1949.) 2s. 6d. [158

Other Countries

Research Council of Israel. Problems of Vole Populations in the Middle-East: Report on the Population Dynamics of the Levant Mole (*Microtus guentheri* D. et A.). By Prof. F. S. Bodenheimer. Pp. 80. (Jerusalem: Research Council of Israel, 1949.) 250 mils: 5s. [118

Western Australia. Report of the Government Chemical Laboratories for the Year 1946. Pp. 34. (Perth: Government Printer, 1948.) [118

International Union of Pure and Applied Physics and Netherlands Physical Society. International Conference on the Physics of Metals (Amsterdam, 12–17 July 1948.) Pp. vii+271. (The Hague: Martinus Nijhoff, 1949.) [118

International Union of Pure and Applied Physics. Symposium on Thermodynamics, Brussels, January 1948. Pp. 137. (Brussels: The University, 1949.) [118

Fondation Universitaire. Vingt-huitième Rapport Annuel, 1947–1948. Pp. 102. (Bruxelles: Fondation Universitaire, 1949.) [118

Annual Report of Ontario Research Foundation, 1948. Pp. 26. (Toronto: Ontario Research Foundation, 1949.) [118

Publications of the Kapteyn Astronomical Laboratory at Groningen. No. 53: On the Distribution of Interstellar Grains. By Prof. Dr. P. J. Van Rhijn. Pp. iii+44. (Groningen: Hoitsema Brothers, 1949.) [118

Annual Report of the Kodaikanal Observatory for the Year 1947. Pp. 5. (Delhi: Government of India Publication Branch, 1948.) [118

Research Council of Alberta. Report No. 53: The Role of Very Fine Mineral Matter in the Hot Water Separation Process as applied to Athabaska Bituminous Sand. By K. A. Clark and D. S. Pasternack. Pp. 22. 15 cents. Report No. 54: Twenty-ninth Annual Report of the Research Council of Alberta, 1948. Pp. 27. (Edmonton, Alba.: King's Printer, 1949.) [118

Canada: Department of Mines and Resources, Mines and Geology Branch. National Museum of Canada, Bulletin No. 104 (Biological Series, No. 32): Botany of the Canadian Eastern Arctic, Part 3, Vegetation and Ecology. By Nicholas Polunin. Pp. vii+304. (Ottawa: King's Printer, 1948.) 75 cents. [118

South African Council for Scientific and Industrial Research. Third Annual Report, 1947–1948. Pp. ix+90. (Pretoria: South African Council for Scientific and Industrial Research, 1949.) [118

Verhandelingen der Koninklijke Nederlandsche Akademie van Wetenschappen, Afd. Natuurkunde. Tweede Sectie, Deel 46, No. 1: Biomorphology in General. By J. C. Schoute. Pp. 93. (Amsterdam: North-Holland Publishing Co., 1949.) 4.50 f. [118

West African Cacao Research Institute. Annual Report, April 1947 to March 1948. Pp. 85. (Tafo: West African Cacao Research Institute: London: Crown Agents for the Colonies, 1949.) 5s. [118

Records of the Geological Survey of India. Vol. 76, No. 15: Notes on Tin and Wolfram in Burma and India. By E. L. G. Clegg. Reprint. Pp. viii+168. (Calcutta: Geological Survey of India, 1948.) 8 rupees; 13s. [118

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Central African Council. A Report on Regional Organisation of Research in the Rhodesias and Nyasaland. By Dr. J. E. Keyston. Pp. iv+91. (Salisbury, S. Rhodesia: Central African Council, 1949.) 5s. [118

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Jamaica. Forest Department Annual Report for the Year ended 31st March 1948. Pp. 8. (Kingston: Forest Department, 1949.) [118

Zentral-Dienst für wissenschaftliche und technisch-volkwirtschaftliche In- und Auslandsliteratur. Jahrgang 1, Nr. 1, Juli. Pp. 32. (Weilheim/Obb.: Gesellschaft für Wirtschaftsplanung und Betriebswirtschaft m.b.H., 1949.) [118

Bulletin of the American Museum of Natural History. Vol. 93, Article 5: Introduction to Quantitative Systematics. By Mont A. Cazier and Annette L. Bacon. Pp. 343–388. 50 cents. Vol. 93, Article 6: A Bibliography of the Herpetology of Japan. By Carl Gans. Pp. 389–496. 1.25 dollars. (New York: American Museum of Natural History, 1949.) [118

Spolia Zeylanica. Vol. 25, Part 1: Revision of the Batocerini (Col., Cerambycidæ, Lamiinæ.) By E. F. Gilmour and John R. Dibb. Pp. 121+10 plates. (Colombo: Colombo Museum, 1948.) 4 rupees. [118